(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

OCTOBER, 1907

A RATIONAL APPRENTICE SYSTEM.

NEW YORK CENTRAL LINES.

Synopsis.

Part III.

The Apprentice Courses or Schedules.

Schedules, or courses, have been arranged for the different trades which are followed as closely as possible. As may be seen, these schedules are sufficiently flexible to meet the needs of the various grades and types of boys who may be enrolled. The shop instructor is responsible for seeing that they are "lived up to" and he must give reasons for any deviations from them. He usually has a schedule for the changes in his shops arranged for a considerable period in advance. He keeps in close touch with the various foremen and carefully studies the situation in the shop, so as not to cripple any one branch or department by making too many changes at one time, or by reducing the quota of boys in a department without taking the proper steps to keep up the work. When changes are necessary he submits his recommendations to the shop superintendent, who approves them and issues the necessary orders to make them effective.

Machinist, boiler maker, tin and copper smith and painter apprentices are to be assigned to the roundhouse for short periods during their apprenticeship. Those who show a liking for drawing are assigned to the drawing room to assist the shop draftsman for periods of from 60 to 90 days. At the Brightwood shops of the Big Four the general foreman, Mr. Bauer, is making a practice of taking some of the apprentices into his office for a short time, to enable them to become familiar with the methods of keeping records and office work in general.

The arrangement of the courses for the various trades is as follows:

MACHINIST—(Four Year Course).

Helping in Shop	0 to 3 months.
Bench Work	6 " 12 "
Light Tool Work	3 " 6 "
Heavy Tool Work	3 " 12 "
In one of either the Air Brake Department, Tool Room or Brass Room	3 " 6 "
Erecting Shop	18 " 24 "

This schedule allows fifteen months above the minimum in the various departments, which can be divided between those in which the apprentice shows the most adaptability.

BOILER MAKER—(Four Year Course).

Heating Rivets, etc	3 to 6 months.
Light Sheet Iron Work	12 " 15 "
Flue Work	3 " 6 "
Riveting, Chipping, Caulking and Staybolt Work	12 " 18 "
Flanging and Laying Out	0 " 3 "
General Work	6 " 12 "

This allows twelve months above the minimum in the various departments, which can be divided between those in which the apprentice shows the most adaptability.

BLACKSMITH (Four Year Course).

Hammer Work and Helping	3 to 12 months.
Light Fire	12 " 24 "
General Work	12 " 24 "
Heavy Fire	3 " 12 "

This leaves eighteen months above the minimum in the various departments which can be divided between those in which the apprentice shows the most adaptability.

MOLDER (Four Year Course).

Helping	3 to 6 months.
Core Work	6 " 12 "
Light Work	6 " 12 "
General Molding	18 " 24 "
Dry Sand	1 " 12 "

This leaves fifteen months above the minimum in the various departments, which can be divided between those in which apprentice shows the most adaptability.

PATTERN MAKER (Three Year Course).

Helping in Pattern Shop	0 to 3 months.
Foundry	3 " 6 "
Machine Work	3 " 12 "
Bench Work	24 " 30 "

This allows six months above the minimum in the various departments, which can be divided between those in which apprentice shows most adaptability.

TIN AND COPPER SHOP—(Three Year Course).

Helping Around Shop	0 to 3 months.
Pipe Work	6 " 12 "
Sheet Iron Work, Including Jackets	6 " 12 "
Tinware	6 " 12 "
Copper Smithing	6 " 12 "

This allows twelve months above the minimum in the various departments, which can be divided between those in which the apprentice shows most adaptability.

PAINTER—(Three Year Course).

Helping	6 months.
Burning Off, Sand Papering and Truck Work	6 "
Rough Stuff and Coating	6 "
Staining, Graining and Varnishing	6 "
Striping, Lettering and Designing	12 "

PLANING MILL—(Three Year Course).

Helping	1 to	4	months.
Running Simple Machines, Including Sharpening and Setting Tools	12 "	20	"
Running More Complex Machines, Including Sharpening and Setting Tools	12 "	20	"
Laying Out Work and Templates, Working from Blue Prints	16 "	28	"

CAR BUILDER—(Four Year Course).

Helping Around Shop	0 to	3	months.
Trucks	6 "	12	"
Platform	6 "	12	"
General Body Work	18 "	24	"

Drawing Courses.

Mechanical drawing, of course, forms the backbone of the educational work. The method of teaching this differs radically from the methods ordinarily used, whether in special drawing schools and classes or in technical schools. As stated on page 205 of the June, 1907, issue, no preliminary geometrical exercises are introduced, but models or actual parts are used from the very first and every step taken is along practical and common sense lines.

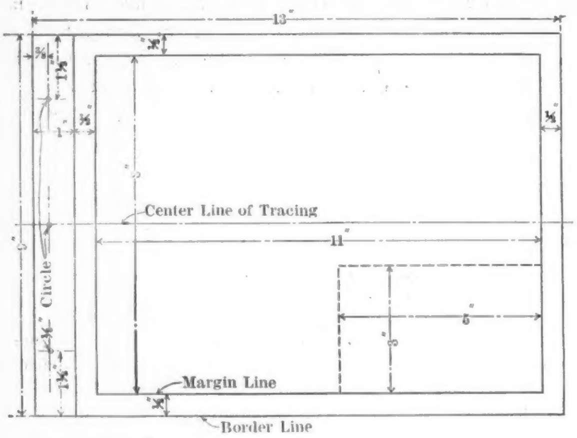


FIG. I.—BORDER LINES ON TRACINGS.

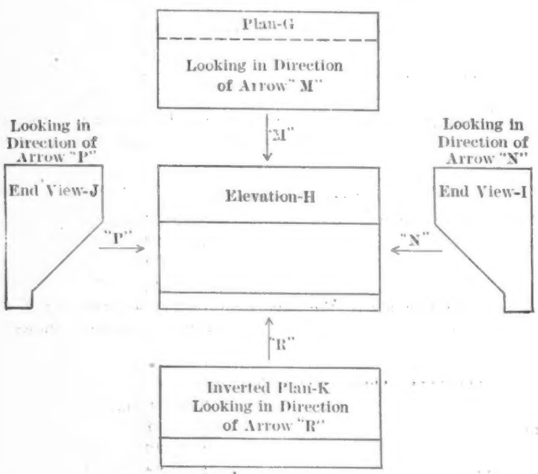


FIG. 2.—ARRANGEMENT OF VIEWS.

GENERAL INSTRUCTIONS.

When the apprentice reports to the drawing school for the first time he is given a drawing board, which is numbered and must be placed in a corresponding space in the case when not in use. He is told to place his name on his T-square and other supplies, is briefly instructed as to the use of the drawing board, T-square and scale and is told how to sharpen his pencil and impressed with the necessity of keeping it sharp. These instructions are made as simple and brief as possible, after which he is given a blue print sheet, about 5½ x 9 in. in size, showing how his paper is to be placed on the drawing board and laid out, how the views of the object are to be arranged on the sheet and the arrangement of the title in the lower right hand corner. At the lower part of this sheet, which is reproduced in Fig. 3, the correct style* of making arrow heads and numerals is shown in contrast with an incorrect style.

* The reproduction does not do this justice.

He is then handed an instruction sheet and model for the first exercise and is told to go ahead. Usually the first drawing is completed two hours after the boy first reports. The instruction sheets are blue prints, 5½ x 9 in. in size, and contain directions as to just what is to be done, thus relieving the instructor to a considerable extent and enabling him to give his attention to each boy as he may require assistance. The instructor must O. K. each drawing before it is removed from the board, and as soon as one is completed he gives the apprentice the instruction sheet and model for the following one. The first exercises are very simple, but they gradually grow more and more difficult, geometrical principles being introduced as they are found necessary. Accuracy is insisted on from the start. Lettering is taught incidentally in connection with the title on the sheet.

In each school room a large blue print sheet is posted, containing the following instructions:

GENERAL.

The longer dimension of a tracing (as a rule) shall be the horizontal one.

A separate drawing shall be made for each detail.

Each tracing shall be bounded by border lines; margin lines shall be drawn ½ in. inside the border lines and parallel to them.

Each tracing shall have a second border line along the left hand end 1 in. outside of the first. Three ⅛ in. circles shall be placed as shown in Fig. 1.

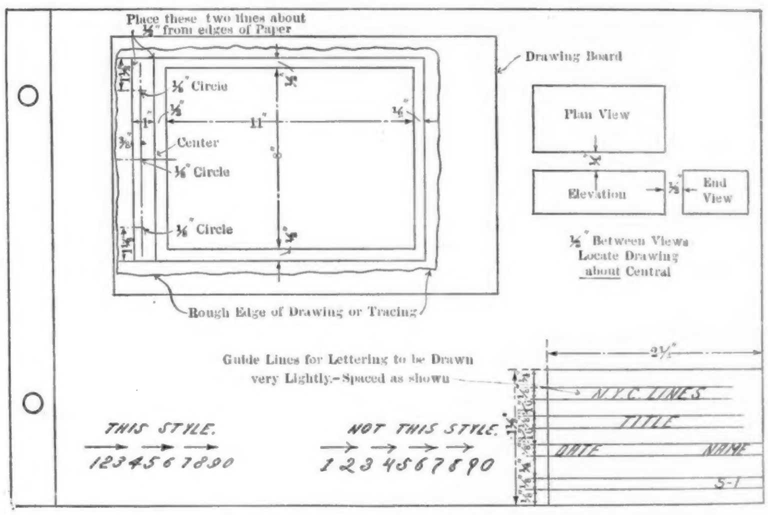


FIG. 3.—GENERAL INSTRUCTION SHEET.

SIZE.

All tracings shall be made on the following sizes (measured over all), each of which shall be known by an initial.

Z — 73 x 36 in.	R — 49 x 18 in.	V — 25 x 18 in.
Q — 73 x 24 in.	P — 49 x 9 in.	T — 19 x 12 in.
Y — 49 x 36 in.	X — 37 x 24 in.	S — 13 x 9 in.

Tracings shall be trimmed 1/32 in. outside of the border lines.

LINES.

Lines shall have the following widths:

Shade and margin lines 3/128 in.
Ordinary and border lines 1/64 in.
Hidden lines (dashes 3/16 in. long, spaces 1/32 in. long) 1/64 in.
Cross section lines 1/64 in.
Dimension lines 1/128 in.
Center lines 1/128 in.

LETTERING.

Letters and figures shall be of the style and size used on this tracing. (See Fig. 3).

VIEWS.

The relative position of the views is to be as shown in Fig. 2. (The views G, H, and I will usually be sufficient).

At least ½ in. should be left between views.

TITLE.

A blank space 3 x 5 in. in the lower right hand corner of the tracing should be reserved for a title.

Wherever possible use the title shown in Fig. 3.

REVISION.

When a drawing has been accepted by an instructor and is returned later for further work it should be reissued by adding "A," "B," "C," etc., after the drawing number in the title. Thus—No. 26-A.

DIMENSIONS.

Dimensions of 24 in. or less shall be given in inches:

Dimensions between 24 and 25 in. are given thus: 2' 0-½". Dimensions over 24 in. are given in feet and inches. Exceptions to this rule (when inches only will be used) are as follows: Diameters of

wheels and boilers. Dimensions of sheets of metal and cloth. Sizes of window glass. Dimensions of cylinders and length of elliptic springs.

Indicate on all drawings whether holes are to be drilled, cored or punched. Thus—13/16" Drill, 5/8" Core, etc.

Master Mechanic's decimal gauge shall be used in specifying sizes of wire and sheet metal.

When the space for a dimension is 1/4 in. or less it is to be placed thus: 1/8".

FINISH.

Surfaces to be finished shall be indicated by the word "finish" opposite them.

CROSS REFERENCES.

Cross references shall be made to various points which require particular attention, thus: 5/8" Drill. See note No. 1.

SECTIONS.

Sections are to be drawn as shown in diagram No. 4.* A section is to be noted where taken by the first letters of the alphabet and the section itself should have below it: Section at A-B.

SHADING.

Shading is to be used as shown in Diagram No. 5*. See the instructor before using shade lines.

* Not reproduced.

THE LOCOMOTIVE COURSE IN DETAIL.

A good idea of the arrangement of the courses and the principles governing them can probably be best conveyed by reproducing some of the more important instruction sheets, by presenting photographs of the models or objects and considering the course for the locomotive department in detail.

In the first exercise, Fig. 4 (a drilling block), the student has little more to do than to copy, except that the sketch on the

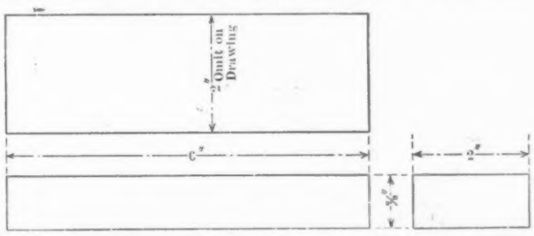


FIG. 4.—INSTRUCTION SHEET FOR FIRST DRAWING EXERCISE.

instruction sheet is not drawn to scale. All of the dimensions are supplied and the views are properly arranged. The dimension marked "omit on drawing" is placed on the instruction sheet to assist the student in locating the drawing centrally on the sheet.

The second exercise, Fig. 5 (a lap joint detail), is a little more complicated and the student is asked to supply the missing view. The use of the dotted or invisible line is also introduced. As an illustration of the care which it is necessary to use in preparing instruction sheets the following incident may be

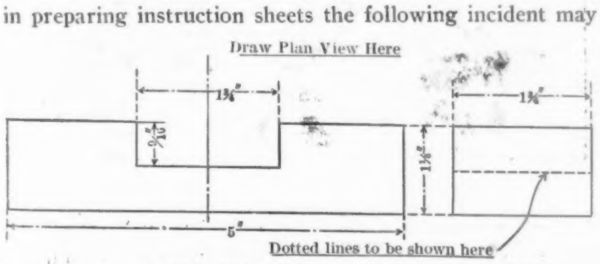


FIG. 5.—SECOND EXERCISE—A LAP JOINT DETAIL.

quoted. On the first sheets which were issued the notation calling for the addition of the missing view read "Plan Here." The boys had been carefully instructed to place the drawings centrally on the sheets, and as this required some calculation before beginning to lay out the drawing, they understood the notation to mean that any preliminary calculations concerning the placing of the views on the sheet were to be made on the spot indicated by the notation. It was necessary to revise it to read "Draw Plan View Here." In the earlier exercises in the course only those notations which are not underlined are to be copied on the drawing. After the apprentices become accustomed to the work it is, of course, not necessary to use such precautions.

In the third exercise, Fig. 6 (a lap joint detail), a missing view must be added which involves the use of the dotted line and certain dimensions are to be supplied, so that the piece will fit the part shown in the previous exercise.

The fourth and sixth exercises, which concern a milling jig and a drill clamp are a little more difficult than the first ones, but do not involve any new principles. The fifth exercise, Fig.

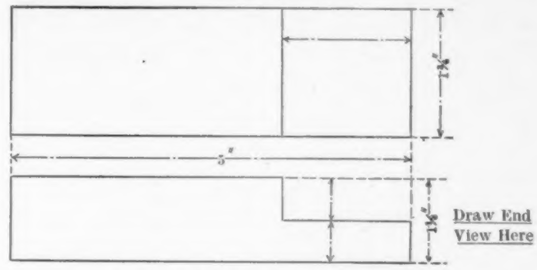


FIG. 6.—THIRD EXERCISE—A LAP JOINT DETAIL.

7 (an anchor plate), does not involve any new principle except that the dimensions are not placed on the drawing but in a table, and the student is expected to locate them properly on the drawing. It must, of course, be understood that none of

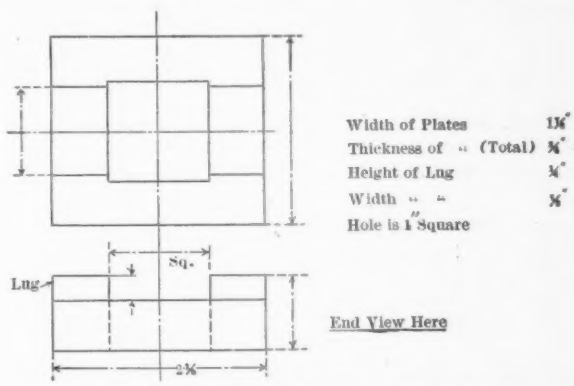


FIG. 7.—FIFTH EXERCISE—AN ANCHOR PLATE.

the sketches on the instruction sheets are drawn to scale so that it is impossible for the student to copy them.

The seventh exercise, Fig. 8 (a pipe center body), introduces for the first time the use of the triangle for the drawing

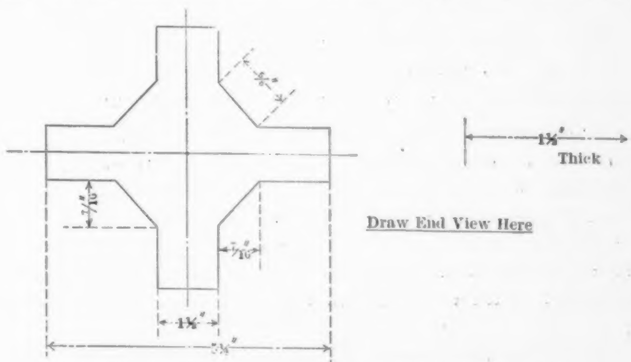


FIG. 8.—SEVENTH EXERCISE—A PIPE CENTER BODY.

of other than vertical lines, and the eighth exercise, Fig. 9 (a planer block), involves the use of the protractor. The next five exercises review the various principles which have thus far been introduced; exercise thirteen, Fig. 10 (a tool jig), being

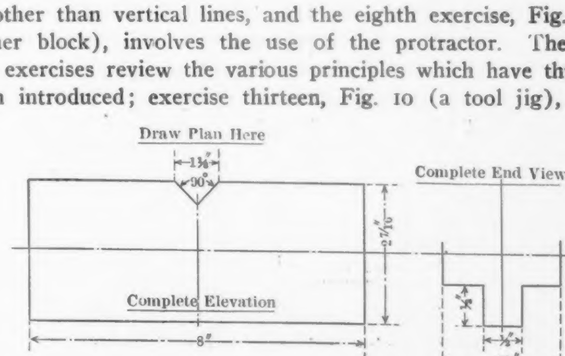


FIG. 9.—EIGHTH EXERCISE—A PLANER BLOCK.

compartively simple and yet requiring more or less thought on the part of the student in order to lay it out correctly.

Exercise fourteen, Fig. 11 (a hose gasket), is the first one

requiring the use of the compass; one missing dimension is to be supplied, but this is obtained by calculation and not from the actual part, although the apprentice has this before him while working.

In exercise fifteen, Fig. 12 (a vibrating cup), sectioning is

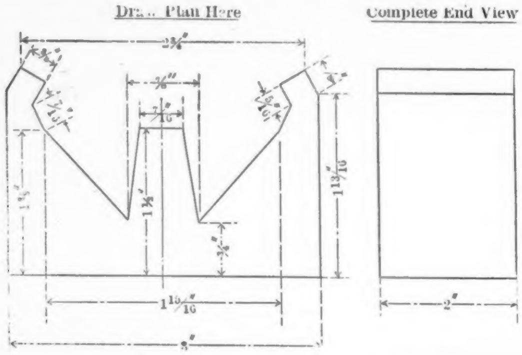


FIG. 10.—EXERCISE THIRTEEN—A TOOL JIG.

introduced for the first time. In the following exercise, Fig. 13 (a handle plate), the student is asked to draw a sectional view without assistance.

The criticism may be made that the exercises are too simple and that the progress is slow, but no one interested has as yet complained of this and experience has demonstrated that every step has been needed; in fact, when the course was revised and rearranged some time ago it was made even more simple than

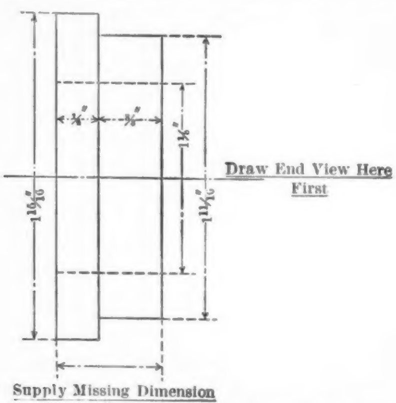


FIG. 11.—EXERCISE FOURTEEN—A HOSE GASKET.

when first introduced. It has been found advisable to cut the more complicated models into two or three sections, and Figs. 14, 15 and 16 are photographs of several of the models, beginning with exercise fourteen, showing how some of them have been cut into sections at the Brightwood school. These views also give some idea of the progress made during the earlier part of the course. The figures near the objects indicate the number of the exercise with which they are used. Although

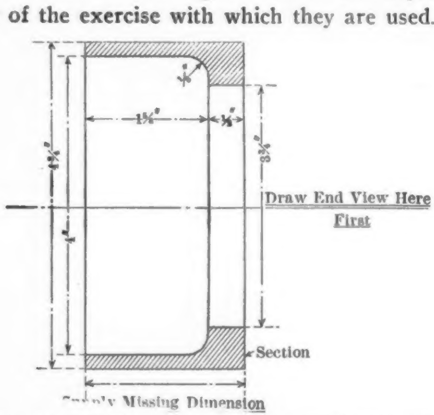


FIG. 12.—EXERCISE FIFTEEN—A VIBRATING CUP.

the aim has been to make each exercise a little more difficult than the preceding one, it has been found advisable in order to interest and encourage the students to occasionally introduce simpler exercises which review some of the more common principles and serve to give the boys some idea of the advancement which they have made.

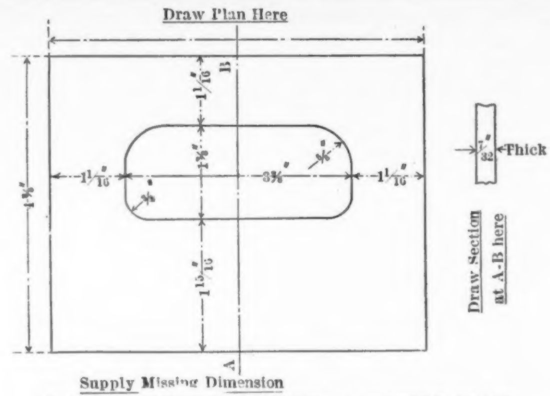


FIG. 13.—EXERCISE SIXTEEN—A HANDLE PLATE.

Exercises seventeen, eighteen, nineteen and twenty, a vestibule guard, bushing, door hasp and spanner nut, are introduced principally for giving practice in the use of the compass. In the first two of these exercises missing dimensions are to be supplied from the model. The last one, Fig. 17, is the first one requiring the division of the circumference of a circle.

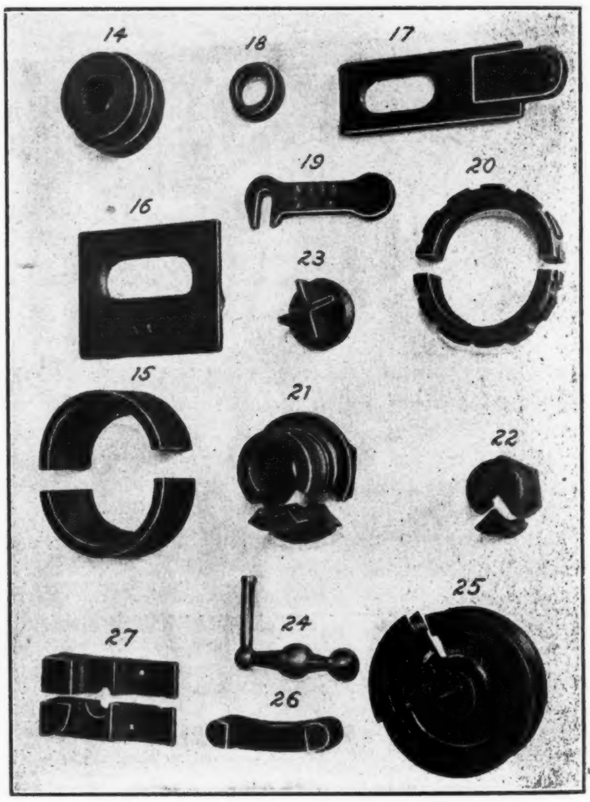


FIG. 14.—NUMBERS INDICATE THE DRAWING EXERCISE.

Exercise twenty-one, Fig. 18 (a brake nut), requires the drawing of a hexagon. The following five exercises, 22, 23, 24, 25 and 26, a check nut, an air valve for an air pump, an injector handle, a flanged pulley and a latch guide, are a little

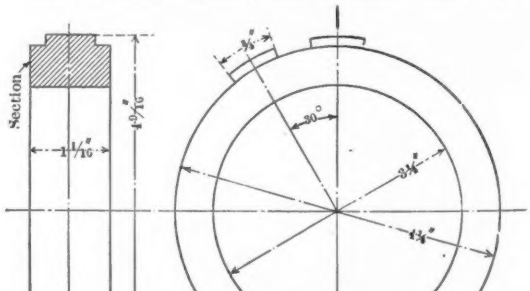


FIG. 17.—EXERCISE TWENTY—A SPANNER NUT.

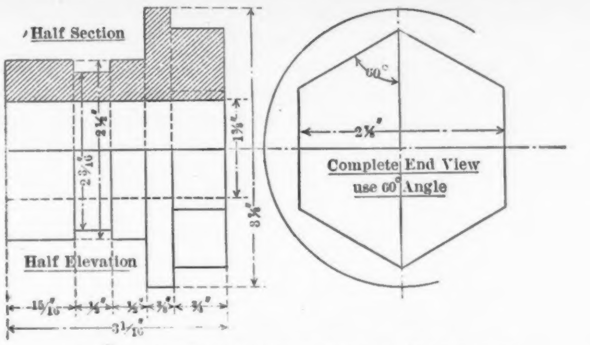


FIG. 18.—EXERCISE TWENTY-ONE—A BRAKE NUT.

more difficult, but do not involve any new principles. Exercise twenty-seven, Fig. 19 (hinge plate), is the first one requiring the laying out of bolt or screw holes. Exercises twenty-eight and twenty-nine, a tool post slide and a lathe saddle, are simple and are introduced mainly to bring into practice the use of the

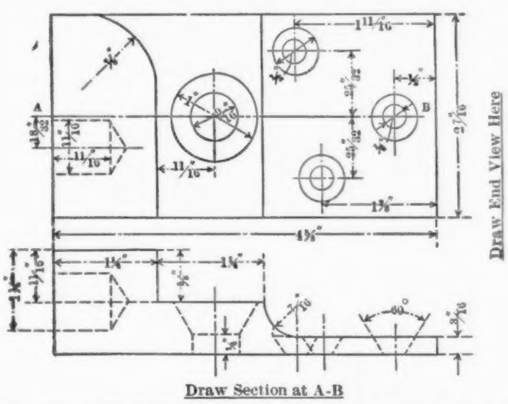
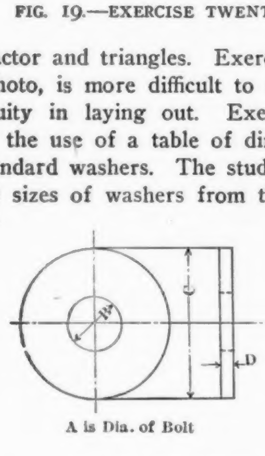


FIG. 19.—EXERCISE TWENTY-SEVEN—A HINGE PLATE.

protractor and triangles. Exercise thirty, as may be seen from the photo, is more difficult to draw and requires more or less ingenuity in laying out. Exercise thirty-one, Fig. 20, introduces the use of a table of dimensions showing different lines of standard washers. The student is required to draw two different sizes of washers from the dimensions in the table.



A	B	C	D
¼"	5/16"	⅝"	.065"
⅜"	7/16"	1"	.083"
½"	9/16"	1⅜"	.12"
⅝"	11/16"	1¾"	.12"
¾"	13/16"	1¾"	.12"
⅞"	31/32"	2"	.134"
1"	1⅛"	2¼"	.165"

FIG. 20.—EXERCISE THIRTY-ONE—STANDARD WASHERS.

Up to this point most of the dimensions have been supplied on the instruction sheets and exercise thirty-two, Fig. 21 (a frame filling piece), is the first one requiring all the dimensions to be supplied from the model or actual part. One reason why such unsatisfactory progress is often made when students start

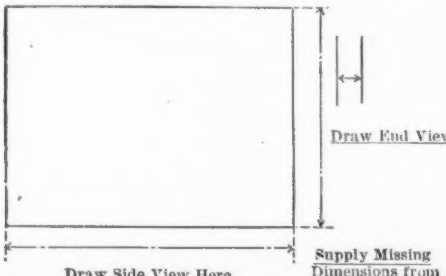


FIG. 21.—EXERCISE THIRTY-TWO—A FRAME FILLING PIECE.

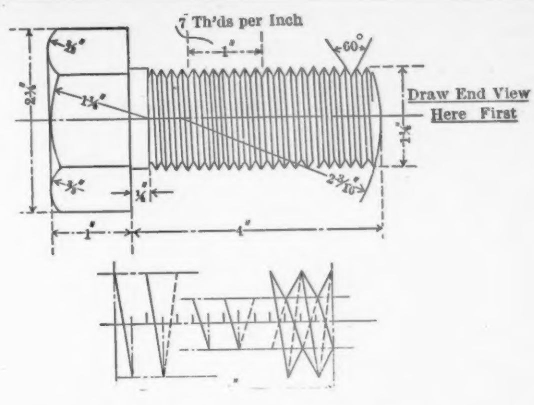


FIG. 22.—EXERCISE THIRTY-FIVE.

to draw the actual parts is that they have not had sufficient preliminary practice in dimensioning drawings. In this course, however, the dimensions are all given and located on the first sheets, then gradually the student is required to supply one, two, or three dimensions, and finally, after he has made thirty-one drawings, he is called upon to supply all the dimensions, but note that the drawing is a simple one and the location of the dimension lines is indicated. This is also true of the following exercise, No. 33. On this drawing a notation is required to the effect that the holes are to be drilled to the size shown. The following exercise, No. 34, an injector nozzle, is quite complicated, as may be seen from the photograph, but does not involve the use of any new principles.

Exercise thirty-five, Fig. 22, is a 1¼-in. bolt with a hexagon head. This involves the drawing of threads and the sketch on the lower part of the sheet is for the instruction of the student and is not to be reproduced on the finished drawing. The fol-

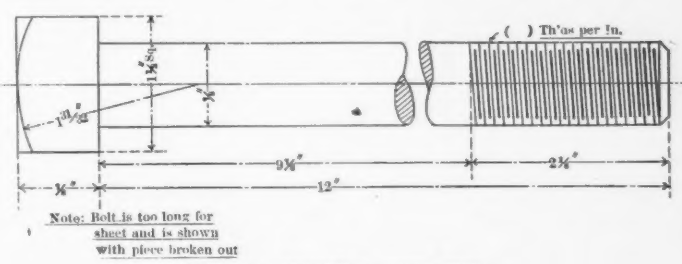


FIG. 23.—EXERCISE FORTY-TWO.

lowing six exercises, which cover an eccentric set screw, a ⅝-in. T head bolt, a regulator spring case, boiler plug, pump valve seat and a hose coupling, are introduced to give the student practice in the drawing of threads.

Exercise forty-two, a ⅞-in. bolt with a square head, Fig. 23, requires that the threads be indicated by the conventional method. It also calls attention to the principle of breaking a piece in order to get the drawing on the sheet.

Exercise forty-four, Fig. 24, introduces a table containing information as to boiler tubes and this instruction sheet is retained by the student to be used in connection with work in his problem course. The following eight exercises do not involve any important new principles and are introduced mainly to fa-

A	B	C	D	E	F
1½"	.393	1.767	.095" .109"	.419 .480	13 12
1¾"	.458	2.405	.095" .109"	.494 .566	13 12
2"	.524	3.142	.095" .109" .12"	.589 .654 .709	13 12 11
2¼"	.589	3.976	.095" .109" .12"	.643 .739 .803	13 12 11

A = Outside Diameter
B = Sq. Ft. Heating Surface per Ft. of Length
C = Area of Section in □"
D = Thickness of Tube in In.
E = Area of Metal in □"
G = Birmingham Wire Gauge

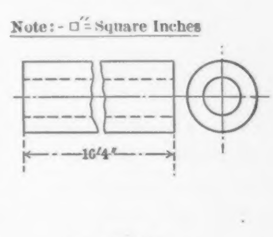
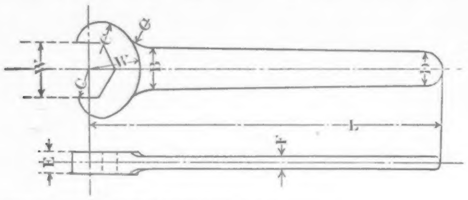


FIG. 24.—EXERCISE FORTY-FOUR—BOILER TUBE DATA.

miliarize the student with the use of tables giving dimensions and data for several different lines and to give him practice in laying out bolt holes.

Exercise forty-six, Fig. 25, is of special interest as it intro-



A	W	B	D	E	F	L	C
5/8"	1 1/16"	7/8"	11/16"	7/16"	1/4"	7 7/16"	5/8"
3/4"	1 1/4"						23/32"
7/8"	1 7/16"						27/32"
1"	1 5/8"						15/16"
1 1/8"	1 13/16"						1 1/32"
1 1/4"	2"						1 [illegible]/32"

Complete Table

B = W x .8
D = W x .65
E = W x .4
F = W x .25
L = W x 7.
A = Size of Nut

FIG. 25.—EXERCISE FORTY-SIX—WRENCH PROPORTIONS.

duces a formula which the student is to use in order to complete the table of wrench proportions.

Exercise forty-eight gives a table of dimensions for several different lines of 90 deg. cast iron elbows and requires the changing of the decimals in the table to fractions. To assist the student in doing this he is referred to the table of decimal equivalents in Colvin's "Machine Shop Arithmetic."

In several of the exercises thus far, the student has been asked to supply most or all of the dimensions, but the dimension lines were located. In exercise fifty-three, Fig. 26 (a coupler

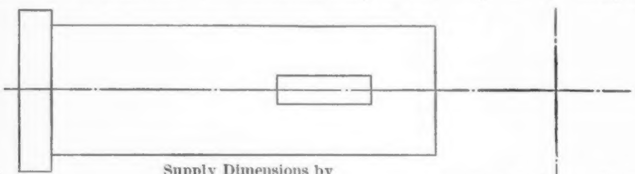


FIG. 26.—EXERCISE FIFTY-THREE—A COUPLER PIN.

pin), the student is for the first time asked to supply all of the missing dimensions with no direction as to how many are to be used, or where they are to be located. The two following exercises, a brake lever and a U-bolt, are similar to this.

Exercise fifty-six, a beveled washer, contains no instructions other than the location of the various views. This instruction sheet is reproduced in Fig. 27. The exercises following this and up to No. 70 review the principles which have been introduced to this point. Several of them contain no instructions other than notations as to the location of the different views, as in exercise fifty-six. The dimensions are in all cases to be supplied

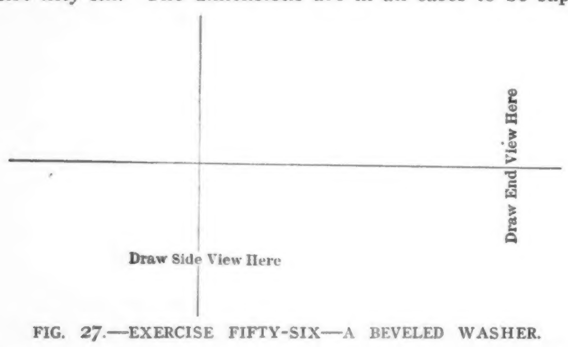


FIG. 27.—EXERCISE FIFTY-SIX—A BEVELED WASHER.

from the object itself, except in one instance, exercise sixty-six, which is rather complicated.

The first sixty-nine exercises are all drawn to full size. Beginning with exercise seventy, Fig. 28, larger objects are considered and they must, of course, be drawn to a smaller scale. These parts are supplied from the storehouse or shop as they are needed. The instruction sheet for exercise seventy is self-explanatory. Each apprentice is assigned a line number and in laying out the crank pin he must use the dimensions for that line. The table must also be copied on the drawing and the missing dimensions be supplied. The next seven exercises are quite similar to this and cover the rear and main crank pins for the Class G engines, which are to be drawn half size; the main crank pin to be drawn to a scale of 3 in. per foot; the quadrant for reverse levers, reverse lever and throttle lever, each drawn to a scale of 3 in. per foot and the M. C. B. standard axles to be drawn to a scale of 1½ in. to the foot.

Beginning with exercise seventy-eight, Fig. 29, the dimensions are taken from the actual parts, instead of from a table of dimensions as in the exercises immediately preceding. The instruction sheet for this exercise needs no explanation. It gives complete instructions to the student as to just what is required. Up to the seventy-eighth exercise the drawings are all such as could be placed on the smaller standard sheet (S). The objects considered have been simple so that only a short time was required to complete the drawing. This served to keep up the interest

FIG. 15.—NUMBERS INDICATE DRAWING EXERCISE.

but after having thoroughly mastered the simpler principles the student is ready to take up the more difficult problems. This is the first drawing to be made on a T-sheet, which, as may be seen from the general instructions, is 19 x 12 in. in size and is the next size larger than S. In the next twenty-eight exercises four are to be drawn on this larger size sheet.

After exercise seventy-eight (the main rod for the G-5 consolidation locomotives) the various parts which go to make up the complete rod are each taken up in detail, the instruction sheets being similar to that for exercise 78. The next eleven exercises consider the main rod strap; rod brasses; adjusting wedge; adjusting wedge bolt; a taper bolt; adjusting wedge liner; grease cup lug; grease cup cap; grease cup stud and grease cup nut. Exercise ninety, Fig. 30, is an assembled drawing of these parts on the rear end of the main rod and contains a table giving the names of the various details, the pattern numbers for the castings and the number of the drawing upon which each is to be found.

In the same way exercises ninety-one to ninety-five, inclusive, consider the piston, piston rod, packing rings, piston plug and piston rod nut for the Class G locomotives. A partial assembled drawing of these is the subject for exercise ninety-six. The instruction sheets are similar to those for the main rod series.

Similarly the next nine exercises cover the back cylinder head, packing gland, and the details of the metallic packing. Exercise one hundred and six is an assembled drawing of the metallic packing.

This is as far as the course has been arranged, but additional exercises are being prepared, and it is the intention to have it include complete drawings of the Class G engines.

Car and Boiler Department Courses.

The car and boiler department courses have not been developed to the extent that the locomotive course has, since the earlier exercises in that course are equally well adapted for the other two. A number of exercises have been arranged for the car department apprentices which consider parts that are only used in the car department, and additional ones will be arranged as they are needed.

FIG. 16.—NUMBERS INDICATE DRAWING EXERCISE.

A large number of exercises have been prepared, or are in preparation, for the boiler department apprentices. These consider various problems in laying out sheets and at some of the schools they are being worked out by all of the apprentices. The apprentices are required to lay out about one in every seven of these to full size on wrapping paper. The boys are also detailed to assist the "layer out" in connection with his work in the shop. This is especially true at the Jackson shops.

Tracing.

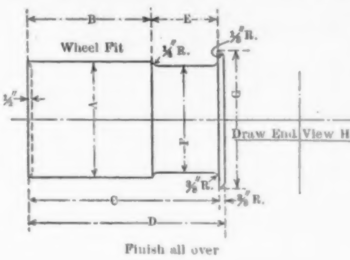
The boys do not start tracing until they have made at least fifty or sixty drawings and then they only make an occasional tracing. Quite often they are given regular work to do, such as tracing drawings which have been made by the shop draftsman, or tracing foreign prints.

Making Blue Prints.

Each school is now being equipped with a frame and tank for making blue prints so that the boys may receive instruction in this and make their own prints.

Examination of Drawings by Instructor.

In checking the drawings the instructor not only checks for accuracy, but questions the boy as to the relation of the views, or other matters, to make sure that he has a clear understanding of what he has done. Very often apprentices who are more advanced are called upon to assist the instructor in checking the



Loco. Class G
Material Forged Steel

Line No.	A	B	C	D	E	F	G
1	5"		11½"		3¾"	5"	7"
2	5"		13½"		3¾"	5"	7"
3	5"		13⅝"		4"	5"	7"
4	5⅛"		12⅛"		4"	5"	7"
5	5"		11¼"		3⅜"	5"	7"
6	5"		10½"		3⅜"	5"	7"
7	4½"		10 3/16"		3 9/16"	4½"	6½"
8	5⅛"		12⅛"		4"	5"	7"
9	5¼"		12¼"		4"	5"	7"
10	4⅜"		11"		3¾"	4⅜"	6"
11	5¼"		12¼"		4"	5"	7"

Supply Missing Dimensions

Note: The numbers refer to eleven different consolidation locomotives
The line numbers correspond to the same line numbers in sheets S-71, S-72, S-73

Scale Half Size

FIG. 28.—DRAWING EXERCISE SEVENTY.

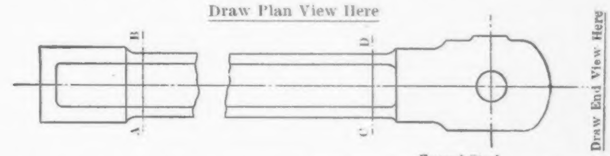
drawings or instructing those who are not as far advanced. This not only assists the instructor, but is splendid training for the apprentice.

The instructor keeps the drawings on file and returns them to the apprentices in lots of fifty, bound in blue print covers, and they then become their property.

The Problem Courses.

The previous educational training of the boys who enroll as apprentices varies so much, some of them having not even re-

Draw Plan View Here



Draw Section "A-B" Here

Draw Section at "C D" Here

Forged Steel

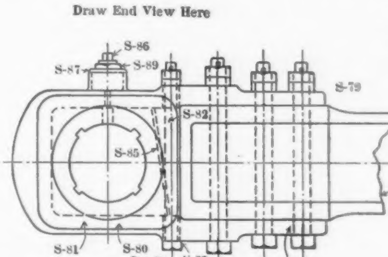
Line No.	Used on	Wt.	No. per Loco.	Gen'l Draw'g
1	Loco's Class. G-5		2	S-90

Complete Sketch with 5 Views on this Sheet
Put in all necessary Dimensions
Indicate Drilled Holes
" Material
" Pattern Number if a Casting
" Number of General (Assembly) Drawing
Make a Finish Drawing on T Sheet, 2" per 1'
Make Table as shown

FIG. 29.—DRAWING EXERCISE SEVENTY-EIGHT.

ceived a complete grade school education, while others are high school graduates, that it is necessary to provide an arrangement which will permit of individual instruction and yet not overload the instructor with too much work. It might be well at

Draw End View Here



Complete Sketch with 2 Views on this Sheet
Put in all necessary Dimensions
Make a Finish Drawing on T Sheet

Mark Drawing Number near each Detail
Drawing Number and Pattern Number (if any) in Detail Table
Make Tables as shown

Line No.	Used on
1	Loco's Class. G-5

Title	Pat. No.	Dwg. No.
Main Rod		T-78
" " Strap		S-79
Rod Brass	L-8990	S-80
" "	L-3030	S-81
Adjusting Wedge		S-82
" " Bolt		S-83
1¼ Taper Bolt		S-84
Adjusting Wedge Liner		S-85
Plug Grease Cup	L-8739	S-86
Cap " "	L-8738	S-87
Stud " "	L-8738	S-88
Nut " "		S-89

FIG. 30.—DRAWING EXERCISE NINETY.

this point to again emphasize the fact that there is no fixed amount of work which must be done by each student, but the courses are arranged to give the slower and less apt students a thorough training in such mathematics as are needed to meet every-day shop problems, and also so that the brighter and more

ambitious boys may advance as far as their abilities will permit. "The results expected are men and not the covering of prescribed courses or the attainment of arbitrary standards." The instructor is in such close personal touch with each apprentice that he can readily determine as to whether the student is doing his best and making an earnest effort to progress. The drawing and class work mark is based on the apprentice's attitude toward his studies as well as on the quantity and quality of the work done.

General Instructions.

The problems are prepared in New York and are mimeographed on loose sheets, which are sent to the various schools. These problems are to be worked out at home on the student's own time. The apprentice is given the first problem sheet and a copy of the following instructions as to how the solutions are to be handed in.

RULES FOR WORKING PROBLEMS.

1. Use only the standard size sheet, 5½ x 8½ in.
2. Do all work in ink.
3. Rule a margin line ¾ in. from left side of sheet.
4. Place the number of the problem in this margin, but do not re-copy the problem.
5. Print the name in the upper right hand corner of each sheet with letters ⅛ in. high.
6. Arrange the work neatly and mark the answer.
7. The signs used in correcting papers will be a check for correct results, and an X for work that is wrong.
8. Questions marked X should be corrected and handed in again.
9. When several sheets are handed in at one time they should be fastened together.
10. Marks will be based on the ability of the apprentice to work out by himself practical problems like those given for home work, and handing in correct answers will not alone count for a clear record unless similar problems can be readily worked.
11. After corrections have been made the home work will be returned to the apprentices, who will keep the sheets for reference.

When the solutions for one problem sheet are turned in the apprentice is furnished with the next sheet. The instructor keeps a record of the sheets which have been assigned and handed in, and follows the progress of each student closely. The solutions are retained by the instructor until the greater part of the class has covered the ground and are then returned to the students and become their property.

The Courses in General.

The problems are not of the abstract numerical kind, but are such as are met with in the shops and drafting room, being clothed in the language of the shop. They are not classified as to subjects, as in text books; they are, of course, carefully selected and arranged, but this appears only after careful examination. The first ones are simple problems in addition, subtraction, multiplication and division, these four subjects being mixed indiscriminately. They gradually become more difficult, taking up the different branches of mathematics, one at a time, but in such a way that the student hardly realizes that he is starting a new subject. In place of first stating the underlying law in abstract, and then giving an illustration, the problem is first stated and solved, and afterwards, if necessary, a law or rule is given. The student is required to work out a sufficient number of problems, of a similar nature, to make the idea take root from the fact of applying and using it. A running review is kept up constantly, as in the drawing course, by introducing problems which bring in points which were previously covered. The interest of the student is stimulated by varying the standard of difficulty and mixing the easy with the hard problems, as they are apt to come in practice.

Occasionally the instructor has the students go to the blackboard during the school session and assigns them different problems. This gives him an opportunity of finding whether they understand thoroughly the work which they have done on the problems and of pointing out errors and rubbing in any principles that are needed.

Two sets of problem courses are now in use, one for the locomotive department and the other for the car department; the problems in both these courses are quite similar, except that those which are distinctively locomotive problems have been omitted and replaced in the course for the car department. The problems, as far as possible, are based on actual figures which are taken from the company's drawings, standards or records; from facts and data which have appeared in the technical press; from suggestions of motive power officers; problems directly from the shop drafting room; hints from the instructors and points which may have come up in conversation with the foremen and mechanics. Each student is furnished with a copy of "Machine Shop Arithmetic," by Colvin, and frequent references are made to this in connection with the different problems, which makes it necessary for the student to refer to it and encourages him in making use of it.

The Locomotive Course in Detail.

The principles which have been followed in arranging these courses can best be illustrated by presenting a number of typical problems which have been selected from the course for the locomotive department.

3. If 6 castings weigh as follows, what is the total weight? 336 lbs., 403 lbs., 210 lbs., 357 lbs., 416 lbs., and 428 lbs.

Although the first problems are very simple they are stated in terms of the shop, and not in abstract, thus at once gaining the interest of the apprentice by giving him a practical application of the principles involved.

Problem. If the same job was divided equally among 25 men, how many even hours would each man work, and how much overtime would one man of the number have to put in to complete the job? Divide the time (377 hours) by 25, and the remainder will be the overtime required for one man.

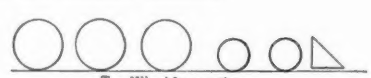
25)377(15
25
127
125
2

15 hours for each man.
2 hours overtime for one man. *Answer.*

When the problem courses were first arranged, special instruction sheets were inserted illustrating the application of new principles, as they were introduced. In revising the course it has been found advisable to discontinue this and as new principles come up, to present solutions of problems, in which they are involved, on the problem sheets themselves, as above.

9. If a casting can be machined at a cost of 67c., what will be the cost of machine work at the same rate on 9,726 duplicate pieces?
Multiply 67 × 9726.
Change from cents to dollars and cents.

In the above case the notation explains the steps which are to be taken to obtain the solution, but leaves the actual work of obtaining it to the student himself.



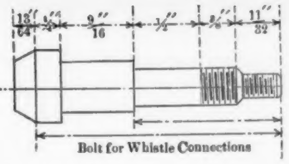
Ten Wheel Locomotive

23. A ten wheel locomotive has a weight of 47.026 lbs. on each pair of drivers and 20,850 lbs. on each pair of truck wheels. Find the weight of the engine.

In revising the problem courses it has been found advisable to use diagrams or sketches in connection with some of the problems to make them clearer and more interesting to the students. This will probably be done to a much greater extent as the courses are revised from time to time.

26. What is the footing of a pay roll per month, which shows 4,537 men each averaging 209 hours at a 29c. rate?
45. Find the weight of a round wrought iron bar 2 5/16 in. in diameter and 9 ft. 6 in. long, if a piece 1 ft. long weighs 14 lbs.?
53. An order for cars is divided among four shops according to their capacity. At the end of three months the first shop has completed 1/10 of the entire order, the second shop 2/7, the third shop 1/5 and the fourth shop 3/10. What part of the entire order is completed?
Add 1/10, 2/7, 1/5 and 3/10.
70 is a common denominator as it can be divided by 10, 7 and 5.
1/10 = 7/70, 2/7 = 20/70, 1/5 = 14/70, 3/10 = 21/70.

A brief note preceded the first problems in fractions, telling what they were and presenting the solution of an example in the addition of fractions. Similar notes and illustrations occur at intervals concerning the subtraction, multiplication and division of fractions. The note in connection with the above problem illustrates the method of reducing fractions to a common denominator.



Bolt for Whistle Connections

55. Supply the "over all" dimensions for the bolt shown in the sketch.

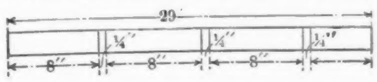
Another illustration of the use of sketches in connection with the problems.

56. A drawing is to have two views placed one above the other. The upper view is 2 3/16 in. high and the lower view 1 9/16 in. high and there is to be ½ in. between the views. If the space inside the margin of the drawing is 8 in. and the work is to be placed centrally on the sheet, how far down will the upper line of the upper view be placed? Show location by a sketch.

Note that the student is here required to present a sketch in connection with the solution of the problem.

61. The total weight of a 12 wheel passenger coach without passengers, but with equipment for electric lighting, is 107,980 lbs. 1/33 of this weight is due to the addition of the electric light equipment; what was the weight on each pair of wheels before electric lights were added?

64. A private car weighs 55 tons. A sleeping car weighs 10/11 of the weight of a private car. A 60 foot passenger coach weighs 9/10 of the weight of a sleeping car. A pay car weighs 8/9 of the weight of a 60 foot passenger coach, and a milk car weighs ¾ of the weight of a pay car. Find the weight in lbs. of the sleeper, passenger coach, pay car and milk car.



75. How many 8 in. pieces can be cut from a piece of stock 29 in. long and how many inches will be left if ¼ in. is wasted per cut?

90. A tender loaded weighs 114,000 lbs. Its capacity is 10 tons of coal and 5,000 gallons of water. What would be its weight with 6 tons of coal and the tank 2/5 filled?

121. If a locomotive burns 1,200 lbs. of coal per hour when going at a rate of 18 miles per hour, how many tons of coal will be burned in going 99 miles at the above speed?

129. What is meant by a Prairie type locomotive? (Type J New York Central). Sketch diagram of wheels.

In each school room a blue print is posted showing the classification of locomotives according to the arrangement of the wheels.

145. With shops running from 6.30 A. M. to 5.15 P. M., with ¾ of an hour for lunch, what would be the day's wage of a boy at 12½c. per hour?

149. What is the weight of a 7 in. channel 10 ft. long when the weight per foot is 1.75 lbs.?

Problem. A lot of screws weigh 69.3 lbs. What will 1/10 of the lot weigh? 6.93 lbs. Answer.

To divide by 10, move the point one place to the left.

163. If a bolt heading machine has the following daily output for one week, what is the total amount to be paid the operator for his week's work at the rate of 13c. for 100 such bolts? 2330, 2060, 1950, 2420, 2310 and 2030?

166. A N. Y. C. tender frame is constructed with four 13 in. steel channels, each 25 ft. 9 in. long, weighing 40 lbs. per foot. Find the weight of steel channels needed for 18 frames.

188. A locomotive is to be extended 3 feet in order to gain heating surface and thus increase the steaming capacity. If there are 375 2 in. tubes, No. 11 gauge, how many sq. ft. of heating surface will be gained in the tubes? For the sq. ft. of heating surface per foot of tube length see drawing plate S-44.

(Note: Heating surface is based on the outside surface of tubes.)

An example of how the problem and drawing courses are "tied together." Several illustrations of this will be found among the following problems.

202. If a planer makes a cutting stroke of 12 ft. in 20 seconds, what is the cutting speed of the tool in feet per minute?

204. A tank requires a plate which measures 8 ft. 10 in. long and 4 ft. 5½ in. wide. How would these dimensions look when placed on the drawing?

(See Rule 14 of drawing instruction sheet posted in class room.)

208. Show by sketch the difference between a box car and a gondola car. Draw only an outline and do not show details.

215. The time between two mile posts is 74.6 seconds; what is the speed in miles per hour?

220. What steam pressure do locomotives now use? Tell where you get your information.

229. A micrometer caliper shows a piece to have a diameter of .678 of an inch. What would be the diameter expressed in the nearest sixteenth of an inch?

235. A blacksmith shop has a floor area of 37,026 sq. ft. If the width is 102 ft., find the length.

247. Find the weight of 25 sheets of ⅛ in. brass, each sheet measuring 16½ in. x 24 in.
(See problem 123.)

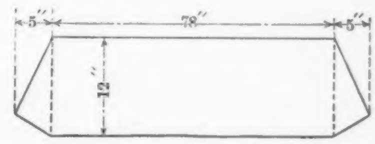
258. Show by a sketch what is meant by a crowned pulley.

259. Why are some pulleys crowned and some straight?

265. On a consolidation locomotive (Type G, New York Central Lines) (See drawing S70-73) how are the driving wheels usually named? Place the names on a sketch like that shown on the blue print of locomotive classification. Also show which wheel the main rod connects with.

The above reference refers to the drawing course.

271. Find the inumber of sq. ft. in a roll of canvas 6 ft. 6 in. wide and 36 ft. 8 in. long.



294. Find the area of this ash pan side by dividing it into two triangles and one rectangle. Add the three areas. The area of the left hand triangle is ½ x 12 x 5.

315. What is meant by a 4¼ x 8 in. journal? Show by sketch which dimension is the diameter. See drawing plate S77.

361. From a sheet of Russian iron 8 ft. square, how many pieces 2 ft. square can be cut. Sketch the sheet and show cutting lines.

In finding the areas of circles in the following problems use table on page 137, "Machine Shop Arithmetic."

367. Three oil cans are the same height, two are 10 in. in diameter and the third 15 in. in diameter. Will the 15 in. can hold more or less than the two others combined. (Compare the areas and show figures.)

395. A bar has a tensile strength of 70,000 lbs. per sq. in. Is it steel or wrought iron? Page 46, "Machine Shop Arithmetic."

Preceding problem 401 is a note to the effect that the areas in the following problems are to be worked out.

404. Find the total pressure tending to blow the head out of an air drum 16½in inside diameter with 90 lbs. per sq. inch air pressure shown by gauge.

421. What would be the pressure on the entire piston of a 10 in. brake cylinder of a passenger coach in an emergency stop with a quick action valve, if the cylinder pressure is considered as 60 lbs. per sq. inch?

Preceding the introduction of percentage is a short explanation of what it is, together with a few typical examples showing how such problems are solved.

429. If a passenger coach with passengers weighs 94,950 lbs. and the passengers weigh 4,500 lbs., what per cent. is the weight of the passengers of the total weight?

432. A drum head 21 in. in diameter is cut from a sheet of ⅜ in. plate 22 in. square. What is the weight of steel cut off? (⅜ in. plate weighs 15.3 lbs. per sq. foot.)

433. In the last problem, what per cent. of the entire metal was wasted?

450. An axle originally weighs 1,038 lbs., and loses 6½ per cent. when turned. What is the final weight? (Nearest pound.)

457. Four groups of men are being paid at the following hourly rates: 23c., 25c., 27c. and 30c. If the pay of each group is increased 2c. an hour, what is the per cent. of increase?

461. A Pittsburgh & Lake Erie Class C locomotive with an Alfree-Hubbell valve has a piston displacement of 7,372 cubic inches. Find the cylinder clearance volume in cubic inches if it is 2.4 per cent. of the piston displacement.

471. If enclosed Pintsch lamps consume ⅝ of a cubic foot per hour for each burner and open burners consume 1 cubic foot per hour, how many cubic feet of gas will be used during 7 hours on a sleeping car with 9 enclosed lamps of 4 burners each, 3 enclosed lamps of 2 burners each, and 4 single open burners?

474. A machinist apprentice planing wedges cuts ½ in. stock from each. If the surface cut measures 5½ in. x 9½ in. what is the weight of cast iron removed from 40 wedges?

For weight of cast iron, steel and wrought iron see page 46 "Machine Shop Arithmetic."

487. Find the weight of a hollow cast iron column 14 ft. long, 10 x 12 in. outside, and ¾ in. thick. Add 75 lbs. for weight of cap and base.

496. Obtain a square bar of wrought iron from the instructor; take its dimensions and figure out the weight at home. Weigh piece at next class and hand in both results with a dimensioned sketch.

505. A 38 ft. tank car has a tank 93 in. inside diameter and 34 ft. long. What is its capacity in gallons?

522. Find the piston displacement, both front and back ends of the following locomotive cylinders:
20½ x 26 in. with 3¾ in. piston rod.
24 x 28 in. with 4¼ in. piston rod.

544. On a 36 in. planer at West Albany the ratio of the cutting speed to the return speed of the table may be as 1 to 2.94. With a cutting speed of 50 ft. per minute what is the return speed? (A ratio of cutting speed to return speed of 1 to 2.5 would mean that return speed was 2.5 times the cutting speed.)

546. The netting in the front end of a locomotive is made of wire marked No. 11 B. W. G. What is meant by B. W. G., and what is the diameter of the wire? (See blue print posted in class room.)

547. A Class F locomotive has a netting in the smoke box 24 x 24 in. made of wire marked No. 11 B. W. G. with a 2½ x 2½ in. mesh. How much space in square inches is open for the passage of smoke and cinders and how much is taken up by the wire itself? (By 2½ in. mesh is meant that there are 2½ wires to each inch.) Ans.: Open 282 sq. in., wire 294 sq. in.

562. In setting valves without a valve setting machine on a G-5 locomotive, it is necessary to find centers by "pinching" and to give the driving wheels at least one complete turn. The locomotive has a total wheel base of 25 ft. 11 in. and 63 in. drivers. How long a piece of track must be available for the job?

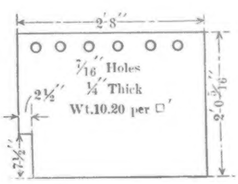
In connection with the course, as outlined above, several extra sheets have been provided containing problems which are to be used where the student does not seem to have gained a sufficient knowledge of the subject from the problems in the regular course. These are assigned at the discretion of the instructor.

The instructors find it necessary to occasionally give short talks to the class as a whole, or to part of it, as new subjects are taken up. These talks are short, simple and informal and as far as possible objects are used as illustrations; for instance, each school is provided with a one-foot cube with its surfaces divided into square inches and with a layer one inch thick removable. This is used in connection with the introduction of the subject of volumes.

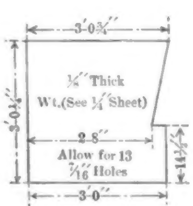
Special Blackboard Exercises.

A number of special problem sheets have been arranged, on the subject of areas, for use as blackboard exercises. The first problems are simple, but the latter ones are quite complicated and require a thorough knowledge of the subject, on the part of the student, for their solution. One of these sheets selected from about the middle of the set is as follows:

Name.......................... Date..............
Do work on blackboard, place answer on this sheet and return to instructor.



Find weight of this side sheet.
Area of large rectangle.
Area of small rectangle.
Area one 7/16 in. hole.
Area of sheet.
Weight of sheet. Answer.

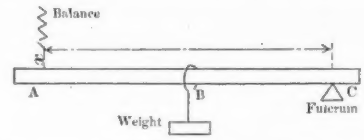


Find weight of side sheet. Answer.

Experimental Work.

In addition to the main problem courses, such as outlined, two supplementary sets of problem sheets have been provided, dealing with experimental work which is carried on during the school sessions. One of these covers the subject of levers, the other valve setting.

Levers.—The apparatus shown in the accompanying drawing and a small fisherman's tubular balance are used with the lever problems. These experiments are worked out by two boys at a time. The first sheet in the series is as follows:



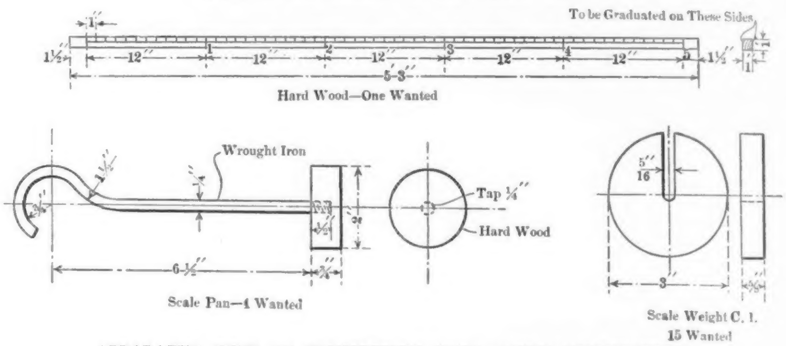
Obtain a light stick, rest one end on a block as a fulcrum and hold up the opposite end of the stick by a spring balance.

5a. Hang a weight of 6 lbs., 5 in. from the fulcrum. Read the spring balance. Notice that the stick tends to turn down on account of the weight and that the balance tends to turn it up about the fulcrum. The weight X its distance from the fulcrum (6 x 5) is called the "moment" of the weight about the fulcrum. The balance pull × its distance from the fulcrum is called the "moment" of the balance pull and this moment is equal to the moment of the weight, otherwise the stick will turn either up or down. A moment is always found by multiplying a force by an arm or distance, and the arm or distance is always at right angles to the force.

In this case multiply the reading of the balance by its arm 30 and see if this moment is equal to the moment of the weight (6 × 5).

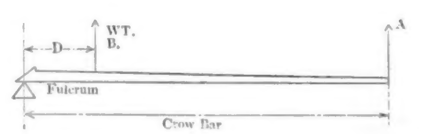
The answer should include the following:
Reading of balance = ?
Moment of balance = ? × 30 = ?
Moment of weight = 6 × 5 = ?

Note.—The reading of the balance is the difference between what it reads before the weight is put on and after. This is because balances do not always read zero at start and also because the stick will show some weight. For example, if the balance reads 1¼ lbs. holding stick alone and shows 2¾ lbs. when the weight is added, the scale reading due to the weight would then be the difference between these weights or the increase in the reading, 2¾ — 1¼ = 1½ lbs.



APPARATUS USED IN CONNECTION WITH LEVER EXPERIMENTS.

After a number of problems of this type have been worked out and checked experimentally, practical applications are considered such as a forge crane, crowbar, belt shifter, reverse lever rigging, throttle lever, foundation brake gear and track scales. A few problems in connection with the crowbar and throttle lever are as follows:



19. If a casting of 100 lbs. weight is to be lifted at B, and if d is 3 in., how much pull will be required at A? Make a sketch with dimensions.

20. If the casting at B weighs 100 lbs. and d is 6 in., what will be the pull at A? Make sketch.

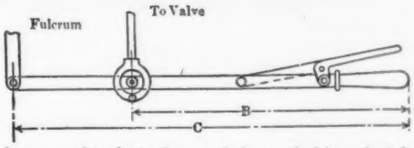
21. If an iron bar at B weighs 560 lbs. and d is 3 in., what is the pull required at A to lift the bar? Sketch.

22. Which will move further when the weight is lifted in problem 9, point A or point B?

23. With d equal to 9 in. and B equal to 230 lbs., what is the pull required at A? Sketch.

24. What would be the pull in the above problem if the bar was only 4 ft. long instead of 6 ft.?

55. A locomotive is fitted with a throttle lever, like that illustrated, where C is 46 in. and b is 40 in. If the throttle lever stem (marked "to valve") is to have a motion of 1¾ in. how far will the end of the handle move?



56. The above engine is to be used for switching, but it is found that the throttle lever is too short to enable the engineer to see the switch signals and still have hold of the lever. If the handle is made 8 in. longer to bring it within the engineer's reach, how much must the fulcrum be moved to give the end of the handle the same motion as at first?
57. If C is 42½ in. and B is 37 in., how far will the end of the handle move when the throttle lever stem moves 2 in.?

Valve Setting.—The small vertical engine, with which each school is furnished, is used in connection with the special problems on valve setting. The first problems or experiments are such as to familiarize the student with the different parts of the engine. The first ten problems are as follows:

VALVE SETTING.

Take the following measurements from the small slide valve engine in the class room and fill in on this sheet—leave this sheet with the instructor. Apprentices will work in groups of two. If engine is provided with link motion place it in full gear forward.

1. Diameter of cylinder—carefully remove top cylinder head. ....in.
2. Length of stroke—do not scratch the guides—use chalk or pencil, or paste on a slip of paper. ......in.
3. Diameter of piston rod. ......in.
4. Length of crank, center to center—from center of crank pin to center of shaft—½ of stroke. ......in.
5. Length of connecting rod (main rod) center to center. Do not take out rod. ......in.
6. Diameter of valve stem. ......in.
7. Total valve travel—the distance that a point on the valve moves ......in.
8. Eccentricity, the distance from the center of eccentric to the center of the shaft—½ valve travel. ......in.
9. If an engine has a stroke of 28 in., what is the distance from the center of the crank pin to the center of the shaft?
10. An eccentric is set with its center 2 in. from the center of the shaft. What is the greatest movement of the valve?

These problems gradually become more difficult and the student is finally asked to set the valves without assistance. Explanatory notes are introduced as found necessary. An idea of the nature of some of the more advanced problems may be obtained from the following, which is taken from one of the later sheets.

Note.—The LEAD is the amount the valve has opened the steam port when the engine is on the center. A valve with ¼ in. lead means that when the engine is on center the valve is open exactly ¼ in. The amount of lead depends on the type of engine and the speed it is to run. The proper lead gives a cushion of steam to the piston and also insures a high effective pressure on the piston early in the stroke.

36. Set the engine in the class room with an equal lead of 1/16 in. at each end. Instructor's O. K...........
37. After instructor has changed eccentric and valve stem, set the valve to give ⅛ in. lead at each end. Instructors O. K.......
38. Turn the engine over slowly and measure the largest opening of the steam port at each end. This is called the port opening. Top..........in. Bottom..........in.
39. Does the valve uncover the port its full width? Find out by turning the engine slowly. ....
40. In the ordinary locomotive fitted with a slide valve, is the space around the valve filled with steam or is it connected with the exhaust? ....

It is proposed after the students have become thoroughly familiar with the working of the small vertical engine, to give them problems concerning the valve motion of the locomotive, and finally to take a light engine out on the track and have the boys set the valves, pinching it back and forth. After they have thoroughly mastered this they will be taken into the shop and taught to set valves in accordance with the standard shop practice. Models of the application of the Walschaert valve gear are being built for the different schools, to be used with this part of the course.

COMMENTS.

It must be kept in mind that the work of the drawing and problem courses, which has been described, is such as would be covered by the average student in a year or year and a half. It will be some considerable time before the courses are finally completed. Some of the boys not having a bent along these lines, but who may make splendid mechanics, will not advance very far. On the other hand, there are sure to be a number of the brighter boys who at the close of the four-year course will have advanced to a very high point. The reader who has followed thus far will undoubtedly be impressed with the practical way in which the educational work is taught, and the fact that although a great many things may have been omitted, which are usually included in the school curriculum, the apprentice has been given a thorough training in those things which will be of practical value to him in connection with his work.

INSTRUCTIONS TO DRAWING INSTRUCTORS.

The following instructions to the drawing instructors, concerning the class work, forms a fitting conclusion for this section of the article and will be of interest.

1. Know personally every student in your class and make yourself familiar with his disposition, ability and ambitions.
2. Make all the work which you give out center around a practical problem, and not around the statement of some abstract law. For example—It is a fact that the product of (1) the revolutions per minute that a wheel is turning and (2) the circumference of the wheel in feet will equal the speed of the rim in feet per minute, but this would be more easily understood from the following problem: If a pulley 4 ft. in diameter turns 200 times a minute, how fast is the rim moving? $200 \times 4 \times 3.14 =$ 2,512 ft. per minute. The idea is thus made definite and explanations and rules naturally follow.
3. Never omit any steps, however simple, in solutions or explanations. If there is one little point about which a student is confused in the early part of the problem, he is sure to miss what follows.
4. Put yourself in the student's place, look at the problem from his standpoint, and do not expect him to grasp instantly that which has taken you years to acquire.
5. While the instruction is in some measure individual, it should be possible to take up many subjects with the class as a whole or with groups. This will save time and effort for the instructor and will create more interest among the students.
6. Make class-room work take the form of explanations and illustrations rather than that of lectures. Encourage questions and make every effort to get the classes as informal and easy as possible. Have something "up your sleeve" for emergencies—extra problems to spring when needed. Never allow the work to drag. Maintain an enthusiastic, brisk, off-hand manner, which will do much to create a wide-awake, business-like attitude on the part of the students. Keep the men busy and good discipline will follow.
7. Encourage students wherever particular advancement is evident. Some men require commendation.
8. Be patient. The slowest men sometimes develop into the strongest.
9. Maintain sufficient assurance at all times to be "boss" of the class. Your decision must always decide, although, of course, you will welcome and profit by suggestions from the class.
10. Do not ask too much of the class, but insist to the letter on whatever you do ask.
11. Do the work thoroughly. It is much more important than to cover a number of subjects superficially.
12. Encourage students to keep note books for the collection of useful information, and to read technical literature.
13. Wherever possible make use of a simple illustration—a picture, a model or a machine part?
14. Strive to make your classes so intensely interesting that students will forget that the attendance is compulsory, and will study because they like it, and not because they have to.

Apprentice vs. Technical School Training.

There seems to be a strong feeling in some quarters to the effect that these two systems are opposed to one another. This is not true; while their final object in one sense is the same—to make men—the material upon which they are to work and the results they hope to accomplish are very different. When we consider the poor manner in which the greater proportion of technical graduates have been equipped for going into practical work, and the serious mistake made in the past by railroads of labeling the college graduate with a title of "special apprentice," and at the same time practically serving notice upon the rank and file that the higher positions were closed to them, and lastly the fact that the provisions for training the regular apprentices have been, as a rule, entirely inadequate for recruiting the ranks or properly fitting the men for their work, it is little wonder that now that the railroads are at last beginning to realize the grave importance of remedying their mistakes in this respect, that the above question should be brought up.

In the first place the technical school does not and cannot undertake the training of the mechanic. Trade schools have been introduced in some parts of the country, but the conditions and requirements of the various manufacturing industries are so different that it is doubtful if the value of such schools can be fully appreciated, except in places where the interest of the community centers about one or two different kinds of industry, and where the schools are operated in close conjunction with industrial works.

Manifestly the only place to train the railroad mechanic properly is in the railroad shop. The large number of railroads (and manufacturing concerns as well) which are investigating the New York Central methods and the fact that several railroads have under way elaborate plans for educating their shop employees argues well for the future, and it is to be sincerely hoped that such work will not stop here, but will be extended to all branches and departments of our railroads.

There should, however, be a close relationship between the apprentice schools and the technical schools. The great defect in our present system is that many of the boys and young men entering our technical schools have only a very vague idea as to what engineering is, or as to what their future work will be. They have simply gathered in a general way that it is a good thing to be a mechanical engineer, an electrical engineer or some other kind of an engineer. How can a technical school divorced from all practical work, and many of whose professors and instructors have only a remote idea concerning the practical application of their engineering knowledge, expect to prepare such men for practical work? You call attention to their magnificent shops and well equipped laboratories, but there is just about as much difference between such shops and laboratories and the ordinary work-shop as there is between light and darkness. You say that they learn to test engines, boilers, etc. Yes, but what if something should go wrong with the engine or boiler, can they fix it, or have they any idea how to take it apart, and put it together again? After finishing a test of a condenser, have they any idea as to what it looks like inside, or how a leak can be stopped? When our technical schools are placed in the hands of practical engineers maybe this will be so, but except to a limited extent it is not true at present.

Some of the more progressive professors have tried to insist that their engineering students spend a part of their summer vacations, at least, in work-shops and this has done much to improve conditions. The practical and common sense method, however, would be to have the learning of the practical work and the gaining of theoretical knowledge go hand in hand. The apprentice school does this to a certain extent and the proper time for the boy to enter a technical school is after he has completed, or partially completed, such an apprenticeship. Many young men are wasting their time at our technical schools who are totally unfitted for engineering work. An apprentice course would serve to weed out those who are not qualified to follow up such work and those who show aptitude for it could take a special finishing course at a technical school and would then prove far more valuable to the railroads than those who have taken a technical course but have had no practical work. As far as the gaining of purely engineering knowledge is concerned the apprentice school can, of course, be only a small factor as this is the real function of the technical school.

[EDITOR'S NOTE.—Since the series of articles on the New York Central Lines apprentice system was first planned, certain important developments have taken place making it advisable for us to add another section, which we expect to publish in our November issue. See editorial in this issue.]

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—The first monthly meeting of the year will be held on Tuesday evening, October 8, in the Engineering Societies' Building, New York. The subject will be "Industrial Education" and a paper on the "College Technical Courses and Apprenticeship Courses Offered by Manufacturing Establishments" will be presented by Prof. John Price Jackson. Dr. Henry S. Pritchett, president of the Carnegie Foundation and of the Society for the Promotion of Industrial Education, and Prof. Dugald C. Jackson, president of the Society for Promotion of Engineering Education, will deliver addresses.

SHOP EFFICIENCY.

BY H. W. JACOBS.*

Considerable attention has recently been given to the various phases of the betterment work on the Santa Fe, the most important of which is that of shop costs with its factors, individual man efficiency as to labor performed and the scientific scheduling of engines through the shop. The paper on this subject presented by Mr. A. Lovell, superintendent of motive power of the Santa Fe, before the recent meeting of the Master Mechanics' Association, attracted considerable attention. As a paper of this kind has limitations as to length, it may not be amiss to supplement, with more extensive illustrations and examples, some phases of the subject, which it was not possible to fully develop in the paper.

The cost problem, while it is helped by the introduction of carefully prepared shop schedules, which are "lived up to," is by no means solved. The problem involves each individual workman and to solve it some method must be adopted that will cause each man to work at his highest average efficiency. This does not mean that he is expected to over-exert himself, but that he is to cut out all unnecessary delays and wastes. The method

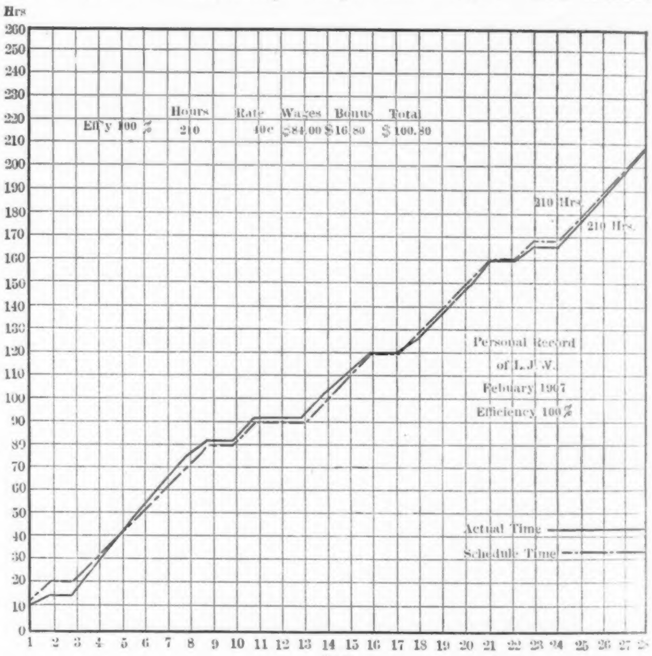


FIG. 1.—INDIVIDUAL EFFICIENCY RECORD OF A GOOD WORKMAN.

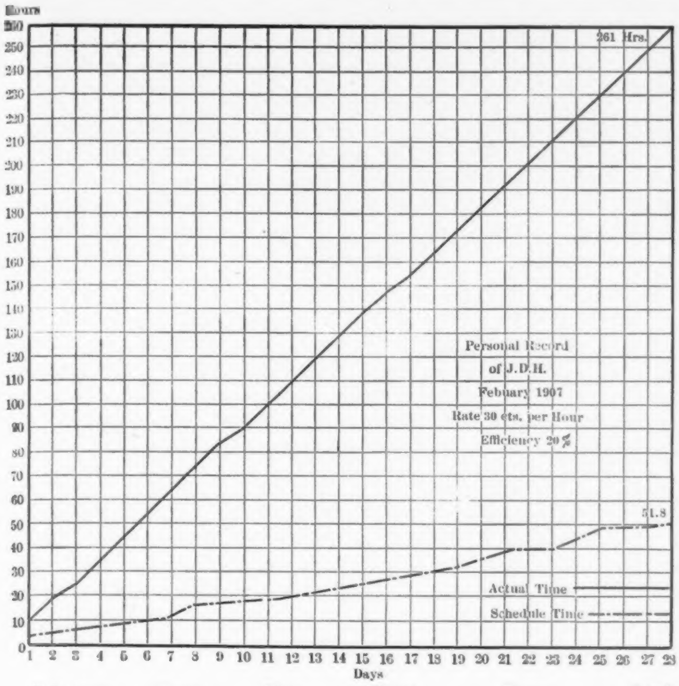
adopted to accomplish this result was the introduction of the individual effort method or bonus system by which each man is able to increase his earnings as he increases his average efficiency.

One very noticeable fact is that the older men are among the highest bonus earners, which is probably due to the fact that they depend to a greater extent upon using their brain power to utilize their available strength, than do the younger men. The accompanying chart, Fig. 1, illustrates the work done by one of the older men in February, and is in several respects ideal. It show the result of steady insistent work, day by day. The full line shows the actual hours worked, which totals 210, while the broken line shows the standard work hours accumulated, which also totals 210, making the man's efficiency for the month 100 per cent. The standard hours are determined by schedules which assign a given time for each operation. The bonus inspector checks up the jobs performed by each man every day and the standard hours accumulated are credited to him.

As an example a lathe operator may have a record as follows:

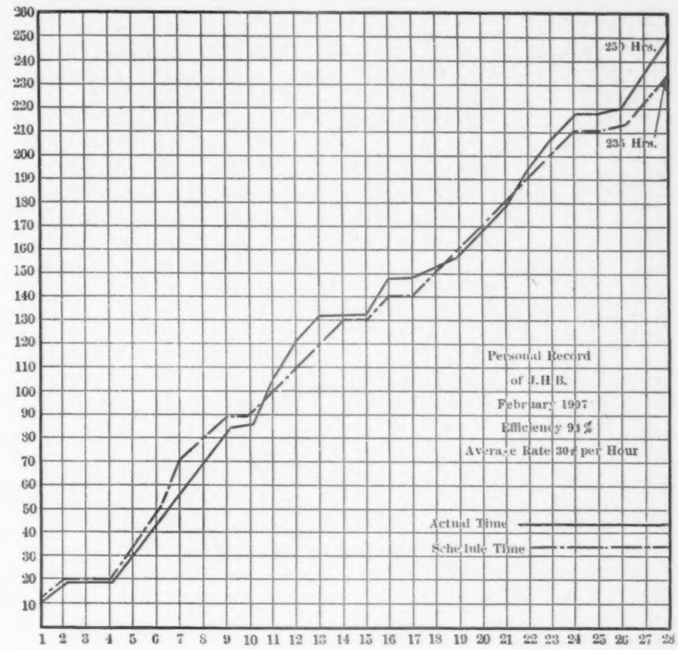
	Standard Time.	Actual Time.
Turn three eccentrics (at 1.3)	3.9	3.3
Turn two small eccentrics (at 1.0)	2.0	1.7
Turn and bore complete six lateral swing castings (at 0.4)	2.4	2.0
Turn and fit complete two knuckle pins (at 1.5)	3.0	3.0
Total	11.3	10.0

* Member American Society of Mechanical Engineers.



Efficiency.	Hours.	Rate.	Wages.	Bonus.	Total.
20%	261	30c	$78.30	——	$78.30
100%	51.8	30c	15.54	$3.10	18.64
				Loss to Company	$59.66
100%	261	30c	$78.30	$15.66	$93.96
20%	261	30c	78.30	——	78.30
				Loss to Man	$15.66

FIG. 2.—EFFICIENCY RECORD OF A POOR WORKMAN.



Efficiency.	Hours.	Rate.	Wages.	Bonus.	Total.
94%	250	38c	$95.00	$12.85	$107.85
100%	235	38c	89.30	17.86	107.16
				Loss to Company	$0.69
100%	250	38c	$95.00	$19.00	$114.00
94%	250	38c	95.00	12.85	107.85
				Loss to Man	$6.15

FIG. 4.—EFFICIENCY RECORD OF A SPASMODIC RECORD.

Eleven and three-tenths hours would then be credited to his efficiency account for the day's work.

The following practical example of cost study is taken from one of the shop time cards from which the workman's wages, bonus and personal records are deduced:

TRUING MALLEABLE IRON PISTON HEAD.

Machine No.	0561
Machine Hour Rate	$0.36
Man's Rate	$0.34
Surcharge to Man	90 per cent
Schedule Time	2.2 hours
Actual January Record	2.25 hours

AVERAGE COST OF EACH OPERATION DURING JANUARY.

Wages	$0.765
Surcharge	0.69
Bonus	0.13
Machine Charge	0.81
Total	$2.395

An unusually hard malleable iron piston head was delivered to the operator who at once protested as he saw that there would be no opportunity for earning a bonus. The work was completed in 8.3 hours. The cost of the operation, in detail, was as follows:

Wages	$2.82
Surcharge	2.54
Bonus	0.00
Machine Charge	2.99
Total Cost	$8.35
Cost with Normal Iron	2.39
Loss	$5.96

Total increase of cost due to hard iron 250 per cent.

This piston head was so badly cracked in putting it on the piston rod that it had to be scrapped and the net loss to the company was $18.40, as shown below:

Cost of turning head	$8.35
Cost of labor for putting head on rod	0.18
Surcharge, 45 per cent. of $0.18	0.08
Weight of head, 535 lbs. at $0.025 per lb.	13.38
3 per cent. for handling material	0.41
Total Cost	$22.40
Scrap value at $0.0075 per lb.	4.00
Net Loss	$18.40

Under the efficiency plan it becomes incumbent on the man to register a protest against improper or defective material to protect his own interests and this institutes a close check on the quality of material delivered to the company.

At 100 per cent. efficiency the workman receives a bonus of 20 per cent. of his wages. For example, the man represented in the chart, Fig. 1, has earned 210 times 40c. or $84.00 and a bonus equal to 20 per cent. of this, making his total income for the month $100.80. For efficiencies below 100 per cent. the bonus is taken from efficiency tables, which are calculated from the bonus curve, Fig. 3.

Fig. 2 illustrates the work of a poor workman, his efficiency being only 20 per cent. His wages for 261 hours at 30c. amount-

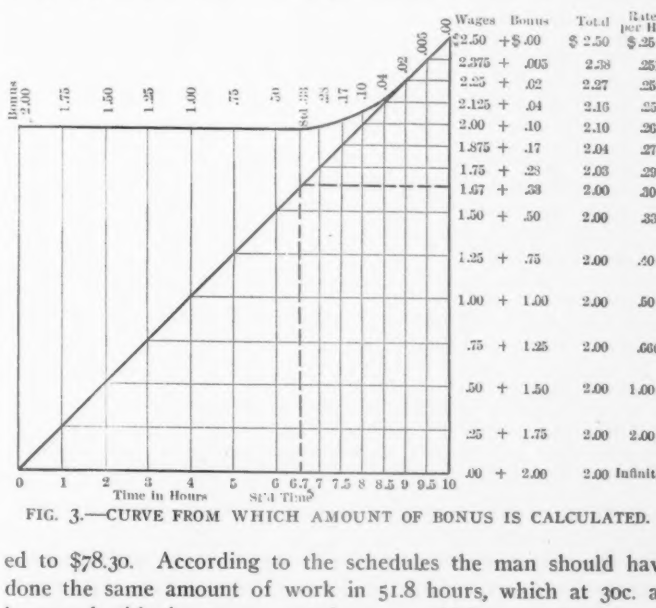


FIG. 3.—CURVE FROM WHICH AMOUNT OF BONUS IS CALCULATED.

ed to $78.30. According to the schedules the man should have done the same amount of work in 51.8 hours, which at 30c. an hour and with the 20 per cent. bonus would have made the total cost to the company $18.64. Due to the inefficient performance of this man the company therefore lost $59.66. If he had attained an efficiency of 100 per cent. in 261 hours he would have had a bonus coming to him of $15.66 in addition to his wages of $78.30, which would have given him a total income of $93.96 for the month. It will be noted that this man worked every Sunday

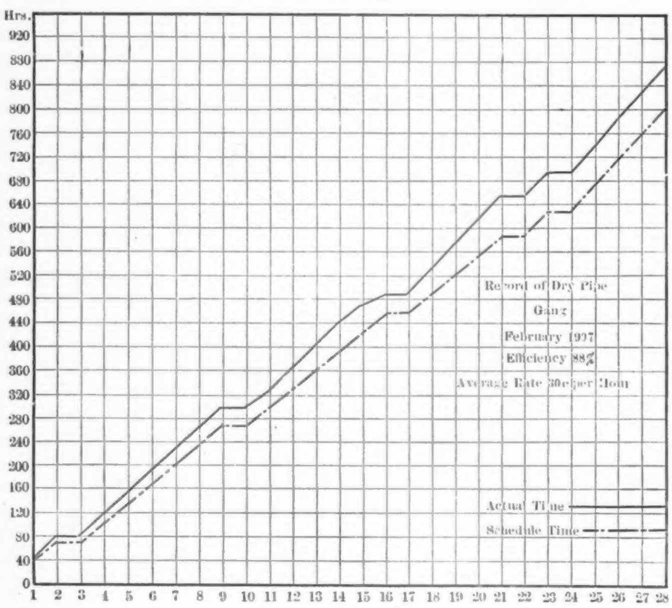
in the month and that he also worked overtime. This undoubtedly had something to do with his low efficiency.

The work of an unsteady and spasmodic workman is illustrated by the diagram in Fig. 4. Such a man can do good work, but is not to be depended upon. If his foreman should want him for a rush job he is very apt to lay off or work at a low efficiency and is apparently of a somewhat emotional nature.

Efficiency charts for the different gangs and departments or for the entire shop are plotted the same as for the individual workers. Fig. 5 shows the work of the dry pipe gang for February, its efficiency for that month being 88 per cent.

The diagram in Fig. 6 shows the efficiency of the repair track for the month of January, during which time there were ten rainy days, the chart distinctly showing the effect of this on the efficiency. During the following month, February, there were less rainy days and the efficiency of the department increased from 72 to 85 per cent.

Fig. 7 shows the efficiency of a shop as a whole. The total number of hours worked during the month was 129,470 and the standard time allowed for performing the various operations was



Efficiency.	Hours.	Rate.	Wages.	Bonus.	Total.
88%	867	30c	$260.10	$19.16	$279.26
100%	768	30c	230.40	46.08	276.48
				Loss to Company	$2.78
100%	867	30c	$260.10	$52.02	$312.12
88%	867	30c	260.10	19.16	279.26
				Loss to Men	$32.86

FIG. 5.—EFFICIENCY RECORD FOR DRY PIPE GANG.

103,335, so that the shop efficiency was 80 per cent. The first day of the month being New Year's day, no work was done. The second day the men came to work and worked at a high efficiency, probably due to the fact that it was the beginning of the month. At the close of the third day the efficiency dropped off slightly, the week closing at a lower efficiency than at the beginning. The sixth day being Sunday, no work was done.

The second week the workmen began with a high efficiency, however showing slight signs of a decrease at the end of the eighth day and slowly decreasing for the rest of the week. The thirteenth was Sunday and no work was done.

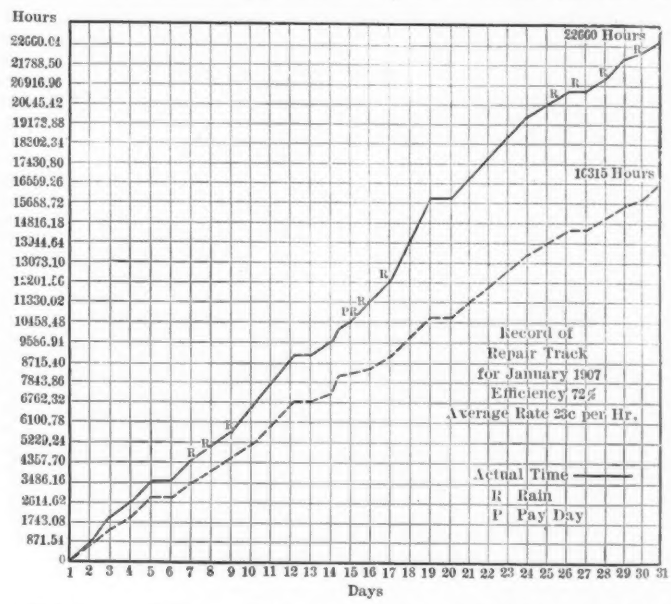
The first two days of the third week the efficiency was high. The effect of pay day, the fifteenth, is shown by the falling off in efficiency on the sixteenth. On the morning of the seventeenth the workmen began to work more efficiently, the week as a whole, however, showing the bad effect of pay day. The twentieth, Sunday, no work was done. The men began the fourth week with renewed efforts, their efficiency being high for the first day, but the next day it again began to drop, closing the week on the 26th with a much lower efficiency than any time during the month. The 27th was Sunday. The men worked very efficiently the rest of the month, falling off slightly on the last day.

The labor and bonus cost of scheduled work for the month at 80 per cent. efficiency was $35,505.52, the total bonus paid amounting to $4,006.83. If this same work had been done at 100 per cent. efficiency the labor and bonus cost would have been $29,822.63, including a bonus of $5,006.83, which would have made an increase to the workmen of $1,000 and a reduction in the cost of the work to the company of $5,683.84. This clearly shows that the greater the bonus paid to the men, the cheaper the work becomes to the company.

RESULTS.

Record of Individual Workmen.—Knowing the efficiency of the individual workmen their advancement to positions of greater usefulness can be automatically determined.

Record of Entire Shop.—By setting "Standard Time" on each operation performed by each workman, after expert analysis of conditions, a totaling of standard times for all operations of all men and actual times can be determined, showing the efficiency of each shop department and for the shop as a whole. By thus determining the efficiency of different division shops a much better comparison of the amount of work turned out can be



Efficiency.	Hours.	Rate.	Wages.	Bonus.	Total.
72%	22,660	23c	$5,109.73	$839.66	$5,949.39
100%	16,315	23c	3,752.45	750.49	3,502.94
				Loss to Company	$2,446.45
100%	22,660	23c	$5,109.73	$1,021.94	$6,131.71
72%	22,660	23c	5,109.73	839.66	5,949.39
				Loss to Men	$182.32

FIG. 6.—EFFICIENCY RECORD OF REPAIR TRACK GANGS.

reached than by the old haphazard method of counting the mere number of engines or cars repaired. This old method is inconclusive owing to there being no set measure of the amount or character of the work done on each car or engine, nor of the condition of the car or engine when received at the shop and when again placed in service. The attempted classifications of character of repairs now in vogue are mostly based on the amount of money spent, with scarcely any reference to amount of work done. Such methods tend to show for the shop with poor organization and high and inefficient labor costs, a more creditable output than that of a shop with good administration and low and efficient labor costs.

By having centralized supervision of detailed operation costs at each shop, it is mathematically practicable to determine the shop where each class of work can be most efficiently performed, and the methods of the efficient shops can be applied to the places whose practice needs improvement.

The system as outlined has reduced the cost of repairs, raised the pay of the workmen and established the output of the shops.

It is a task in itself to urge and develop practically such methods. It is a greater task to convert others into sympathy and co-operation with new ideas so that the workmen will not feel that it is a scheme to get something from them for nothing and

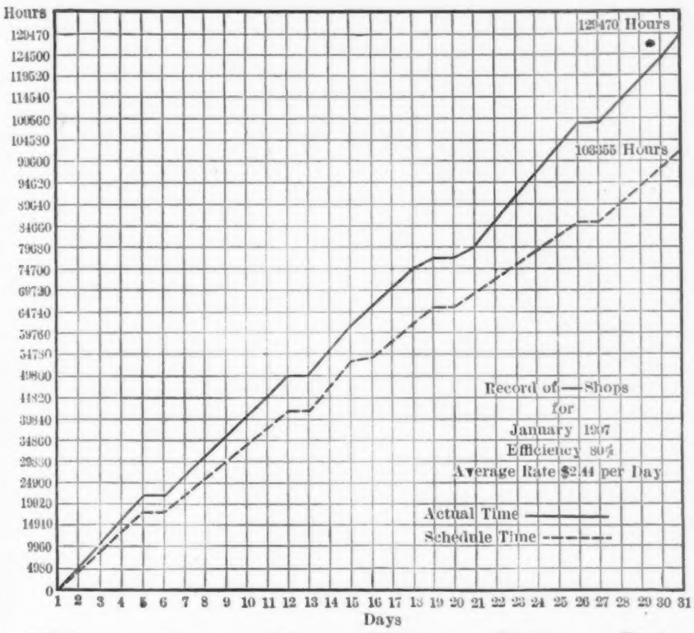
to take away their liberty, but that they may be brought to realize that while the plan helps the railroad it also helps the workmen in a fair proportion.

SHOULD THE JURISDICTION OF THE STOREKEEPER EXTEND TO THE TIME THE MATERIAL IS ACTUALLY USED.*

By H. A. ANDERSON.†

This subject is one which in a measure interests all departments of a railroad and more especially the motive power and roadway departments. These two departments consume practically 95 per cent. of the material and on a large railroad where the amount handled and charged to closed accounts may represent as much as five million dollars per month, it is obvious that more or less of the material drawn from stock will be left over, due to the fact that it is impossible in all cases to estimate exactly just what amount of each item will be required.

You will no doubt find that most of the men using material do not appreciate the enormous expense involved in carrying more supplies than actually required, and while some of them



Efficiency.	Hours.	Rate.	Wages.	Bonus.	Total.
80%	129,470	$2.44	$31,499.69	$4,006.83	$35,506.52
100%	103,335	2.44	24,815.80	5,006.83	29,822.63
				Loss to Company	$5,683.89
100%	129,470	$2.44	$31,499.69	$6,318.13	$37,817.82
80%	129,470	2.44	31,499.69	4,006.83	35,506.52
				Loss to Men	$2,311.30

FIG. 7.—EFFICIENCY RECORD OF A SHOP.

are perfectly willing to return the excess stock, charged out, to the general storehouse from which it was drawn, many others are unwilling to part with it unless compelled to do so. While it is true that the men doing the actual work are naturally best qualified to determine what amount of material they should have, you will find a tendency to over-estimate, with the result that certain work will be overcharged, and if not properly controlled by some one department, the excess material in many cases is left lying around, depreciating in value, or is perhaps used for some other purpose without the proper charge being made.

Material drawn from stock and charged out, but not put in actual use, will not receive the same care and attention it would if it was carried as an asset under the direct charge of a supply agent or storekeeper. It will be found that on many railroads, where material is drawn from stock and charged out, the responsibility of the stores department ceases and it then comes under the care of a foreman or a road supervisor, who does not, in most cases, realize the necessity of properly accounting or caring for it, and the railroad becomes the loser. This division of responsibility is not conducive of good results and it has a tendency to increase the stock rather than keep it within reasonable limits, for the reason that the stores department in making up requisitions cannot take into consideration material charged out but not consumed.

If all material, whether in stock or charged out and not consumed, was placed under the direct charge of the supply agent and storekeeper, whose entire time and attention is given to this subject, the best results should be obtained. It is, of course, understood, that such officers should be well informed as to the use of material for various purposes, which can only be accomplished by personal and direct contact with the work under way and by interviewing those in charge of such work.

In this connection we must not overlook the question of responsibility over scrap. All scrap, with few exceptions, has, like new material, a market value and represents so much money invested. On some roads the stores department is held responsible until it is disposed of, while on others it is carried under the jurisdiction of a foreman. If the scrap pile is not gone over intelligently to recover good parts and the balance sorted according to its class and character, the railroad company cannot expect to get the full benefit of the credits they are entitled to.

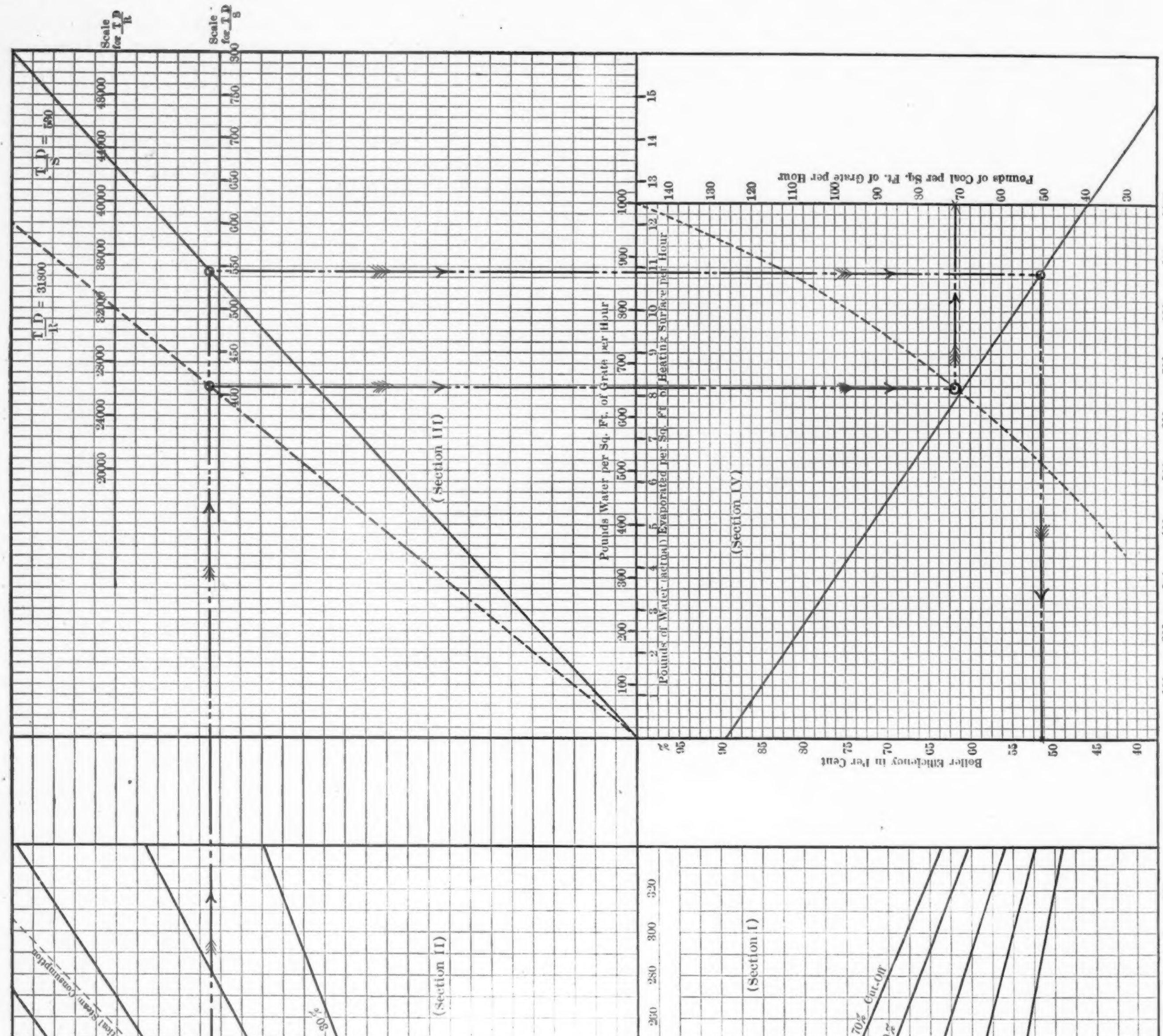
It is just as important to have a well regulated system of handling and caring for scrap, as for new material, and it will be found, where proper care and judgment are exercised in dealing with this class of material, that you can frequently pick out good material and avoid the purchase of new.

The constant increase in cost of material used by our railroads necessarily means the outlay of additional capital and this fact alone makes it all the more obligatory on our part to keep the amount of stock reduced to the minimum consistent with safety. To do this the stores department must control all material, new as well as scrap, charged out or not, and must be given full authority to handle it for the best interests of the service and by centering the responsibility it will enable the department to give a more accurate account of material on the system.

* Abstract of a paper read before the Railway Storekeepers' Association.
† Special Agent, Purchasing Department, Pennsylvania Railroad.

FREIGHT CAR EFFICIENCY.—It can hardly be disputed that it is to the mutual advantage of the railroads of the country to strive continually to secure the highest possible efficiency from the equipment, regardless of the temporary condition of any individual road as regards car supply. The average per cent. of cars in shops for all roads reporting is 5.48 per cent. It will be noticed that the per cent. of the individual roads varies considerably, many of the larger roads being above the general average, and it is evident that there is room for improvement in the shop situation. It is customary on many roads to make reductions from time to time in shop expenses. This may not occur often when there is a local shortage, but it does occur frequently when there is a general shortage, and the effect of this policy on the general efficiency will be better appreciated when it is considered that a decrease of but .5 in the per cent. of cars in shop would be equivalent to an increase of 9,490 cars with an approximate value of $9,500,000.' The benefit would not be confined to the general situation. It is certainly poor economy for the individual railroad to allow shop cars to accumulate which have a per diem value of 50 cents, merely to make a temporary reduction in maintenance of equipment expenses. Similarly, an increase in the loaded mileage of 1 per cent. would make available 18,980 additional cars. By raising the average loading but one ton per car, the available cars could be increased by 69,457. An increase of 1 mile per car per day means 79,395 more cars, the value of which at the average earnings for the country approximates $200,000 per day.—*Arthur Hale, Chairman, Committee on Car Efficiency, The American Railway Association.*

BRICK ARCH TO REDUCE SMOKE.—A more conclusive test of the brick arch is desirable because the tests so far made show that gases and smoke given off by the coal are more thoroughly burned in fireboxes equipped with brick arches, and less black smoke given off.—*Report of Committee, Traveling Engineers' Association.*


(Section I)
(Section II)
(Section III)
(Section IV)
Revolutions per Minute
Running Tractive Force in Per Cent of Maximum Tractive Force
Pounds of Water per Hour per Unit of Maximum Cylinder Duty
Boiler Efficiency in Per Cent
Pounds of Coal per Sq. Ft. of Grate per Hour
Pounds Water per Sq. Ft. of Grate per Hour
Pounds of Water (actual) Evaporated per Sq. Ft. of Heating Surface per Hour
W = Pounds of Water per Hour
T = Max. Cylinder Tractive Force
D = Driving Wheel Diameter
70% Cut-Off
Theoretical Steam Consumption
W / T D

A METHOD OF PLOTTING LOCOMOTIVE CHARACTERISTICS.

BY LAWFORD H. FRY.

The diagram shows a system of plotting the results of locomotive tests to give a series of characteristic curves which cover the whole range of operation. It is divided into four sections. In the lower left hand corner, Section I, is a series of curves which give the relation between the cylinder tractive force, the cut-off and the speed. The curves in the upper left hand corner, Section II, show the relation between the hourly water consumption, the cut-off and the speed; the curves in the lower right hand corner, Section IV, show the hourly coal consumption and the boiler efficiency for any given conditions.

The four sections of the diagram are placed so that for any given combination of tractive force and speed the corresponding water and coal consumption may be determined readily.

The curves in the diagram are characteristic of a modern high speed balanced compound locomotive. They have been plotted from the Pennsylvania Railroad tests at St. Louis and are a combination of the results obtained with the New York Central Cole balanced compound and the Atchison, Topeka & Santa Fe Vauclain balanced compound. Both these are Atlantic type engines and on the testing plant gave very similar results.

In Section I the horizontal scale is revolutions per minute, while the vertical scale is indicated cylinder tractive force expressed in per cent. of the maximum tractive force given by formula. In this case, the locomotives being four-cylinder compounds, the maximum tractive force is given by the formula:

$$T = \frac{d^2_h \times s \times \frac{2}{3} P}{D} + \frac{d^2_e \times s \times \frac{1}{4} P}{D}$$

where

$T =$ the maximum tractive force in pounds.
$d_h =$ the diameter of the high pressure cylinder in inches.
$d_e =$ the diameter of the low pressure cylinder in inches.
$s =$ the stroke in inches.
$P =$ the boiler pressure in pounds per square inch.
$D =$ the driving wheel diameter in inches.

The diagonal lines show the cylinder tractive force at any speed for a given cut-off in the high pressure cylinder. For example, at 50 per cent. cut-off the tractive force falls from 80 per cent. of the maximum at 80 revolutions a minute to 40 per cent. of the maximum at 320 revolutions per minute. And, again, if a vertical line is drawn corresponding to 200 revolutions a minute it is found that at 30 per cent. cut-off the tractive force is about 37 per cent. of the maximum, at 50 per cent. cut-off the tractive force is about 60 per cent. of the maximum, and at 70 per cent. cut-off about 83 per cent. of the maximum tractive force. These figures apply only to the cylinders and do not indicate whether the boiler can supply sufficient steam to maintain the speeds at the cut-offs mentioned. The question of steam consumption and supply is determined by the remainder of the diagram.

The steam consumption is shown by the curves in Section II in the upper left hand corner of the diagram. Here the horizontal scale is revolutions per minute, as before, while the vertical scale measures the water consumption, and a curve is drawn for each cut-off to show the water consumption for the various speeds.

In order to make the curves generally applicable to locomotives of the type under consideration the water consumption is not given directly in pounds, but is referred to the factor T D, which depends on the cylinder volume and the boiler pressure. To get an idea of the absolute amount of water represented by these curves it may be assumed that the maximum tractive power (T) of the locomotive for which the curves are drawn is 22,000 pounds and the driving wheel diameter (D) 80 in., making the factor T D = 1,760,000. Therefore the figure for water consumption given by the curves, if multiplied by the factor 1,760,000, will give the total water consumption in pounds per hour. For example, with a cut-off of 50 per cent. at 200 revolutions per minute the water consumption will be 0.0205 × 1,760,000 = 36,080 pounds per hour. If another locomotive of the same type, but different dimensions, is considered the water consumption will vary in proportion to the changes in the maximum tractive force and the driving wheel diameter.

The diagonal lines in the upper right hand corner, Section III, enable one to change from the total hourly water consumption in Section II to the rate of evaporation per square foot of grate area or per square foot of heating surface. There are two horizontal scales, one the rate of evaporation per square foot of grate corresponding to the heavy diagonal marked $\frac{TD}{R}$, the other the rate of evaporation per square foot of heating surface corresponding to the light diagonal marked $\frac{TD}{S}$. As indicated by the broken lines it is only necessary to draw a horizontal line from the point of total water consumption, and then from the point of intersection with the diagonal to drop perpendiculars to the scales of evaporation. The position of these diagonals is determined for each particular locomotive by the respective relations of the grate area and the heating surface to the cylinder factor TD. The diagonals drawn in the diagram are for a locomotive in which the grate area is to the cylinder factor TD as 1 is to 31,800, or $\frac{TD}{R} = 31,800$, and the heating surface is to TD as a is to 530, or $\frac{TD}{S} = 530$, R being the grate area and S the heating surface in square feet. To enable the diagram to be applied to locomotives having other proportions of grate area and heating surface, the scales for $\frac{TD}{R}$ and $\frac{TD}{S}$ have been drawn. To get the diagonal for any given proportions it is only necessary to draw a line from the origin through the proper point on the scale.

In the lower right hand corner, Section IV, curves of coal consumption and boiler efficiency are plotted. The coal consumption curve has as its base the rate of evaporation per square foot of grate, while the boiler efficiency curve is based on the rate of evaporation per square foot of heating surface. By continuing down the perpendiculars from Section III to intersect the curves the rate of coal consumption and boiler efficiency which correspond to the given conditions are found.

From the foregoing it will have been seen that the four sections of the diagram cover the complete economy of the operation of a locomotive. The broken lines show the process of tracing out the values for a given combination of tractive power and speed. In the case chosen the locomotive is required to develop 60 per cent. of the maximum tractive force at 200 revolutions per minute. With the dimensions of the locomotive from which the curves are constructed this would be approximately an indicated tractive force of about 13,200 pounds at 47.5 miles an hour. From Section I it is seen that this combination requires a cut-off of 50 per cent. Carrying the perpendicular from this point up to the water line for 50 per cent. cut-off in Section II, it is seen that the water consumption is 0.0205 pounds per unit of cylinder factor (TD), or with the assumed dimensions 36,080 pounds an hour. Taking a horizontal line across to cut the diagonals in Section III and then dropping perpendiculars from the points of intersection, the exaporation per hour is found to be about 650 pounds of water per square foot of grate area and about 10.9 pounds per square foot of heating surface. By continuing the perpendiculars down to intersect the curves in Section IV it is found that the above conditions require about 71 pounds of coal to be fired per square foot of grate area per hour, while the boiler efficiency will be about 52.5 per cent. These curves of boiler efficiency and rate of firing are based on the St. Louis tests with a coal of high fixed carbon and would have to be changed for a different grade of coal.

Steam Consumption Curves.—It is interesting to compare the steam consumption curves in Section II with the line of theoretical steam consumption, assuming that the cylinders at the point of cut-off are completely filled with steam at the full boiler pressure. On this assumption the steam consumption

would be increased directly in proportion to the speed and would be represented by a straight line, as is shown by the dotted line for 50 per cent. cut-off. The actual and the theoretical lines cross each other at about 220 revolutions per minute, and the actual curve lies above for lower speeds and below at the higher speeds. A possible explanation for this is that at the lower speeds the cylinder condensation and the leakages past the piston cause more steam to be used than can be contained in the cylinder at the full pressure, while at the higher speeds the wire-drawing offsets the losses and the cylinder cannot take in its full supply of steam.

The Tractive Force Curves.—The tractive force curves in Section I show a decreasing tractive force with increasing speed. These curves are practically straight lines and apparently converge to a point on the line of zero tractive force at about 580 revolutions per minute. This with a stroke of 26 in. would give a mean piston speed of about 2,520 feet a minute. The drop in the tractive force with increasing speeds is due to the wire-drawing of the steam through the steam passages and the convergence of the lines indicates that at a piston speed of about 2,520 feet per minute, with any cut-off, the entire energy of the steam would be absorbed in overcoming friction and no tractive force would be produced. Of course such a speed is impracticable as the highest speed which can be attained is that at which the tractive force is just sufficient to overcome the friction of the machine. In the AMERICAN ENGINEER AND RAILROAD JOURNAL for November, 1906, page 441, was published an abstract of a paper by Prof. W. E. Dalby in which he plotted a similar series of tractive force curves from Prof. Goss' experiments.

Cylinder Factor.—The cylinder factor (TD), that is, maximum cylinder tractive force multiplied by the driving wheel diameter, was proposed by the author in the AMERICAN ENGINEER AND RAILROAD JOURNAL, October, 1902, page 315, as a useful factor in the comparison of locomotives and has since then found considerable use. It has, however, suffered under the disadvantages that it did not represent an actual physical quantity. Mr. H. A. F. Campbell has recently pointed out to the author that this disadvantage can be removed and the factor may be shown to have a concrete value.

It can be shown that the factor TD is proportional to the foot-pounds of work done in the cylinders at each revolution, and is therefore properly known as the cylinder-duty-factor. When the tractive force is T pounds and the driving wheel diameter is D inches the locomotive at each revolution of the driving wheels moves forward πD inches and does πTD inch-pounds or $\frac{\pi}{12}TD$ foot-pounds of work in the cylinders. That is, T D multiplied by $\frac{\pi}{12}$ or 0.262, gives the foot-pounds of work done in the cylinders at each revolution.

The factor TD divided by the heating surface $\frac{TD}{S}$ or BD, (B representing the tractive force T divided by the heating surface) has been used as a measure of the steaming capacity of a locomotive. Its value is perhaps increased if instead of considering it as an abstract conception it is realized that this steaming capacity factor, $\frac{TD}{S}$, is proportional to the foot-pounds of work done per square foot of heating surface in each revolution. To get the actual number of foot-pounds per square foot of heating surface the factor is to be multiplied as above by 0.262.

In giving a meaning to the vertical scale of steam consumption, $\frac{W}{TD}$, of the curves in Section II it is better not to think of TD as proportional to the foot-pounds per revolution, but to take into consideration the fact that TD is very closely proportional to the weight of a cylinder full of steam at the maximum cut-off. From this point of view the steam consumption is measured on a scale giving readings which are proportional to the number of maximum cylinderfuls of steam which are used per hour.

STATISTICS OF RAILWAYS IN THE UNITED STATES.

The 19th annual statistical report of the Interstate Commerce Commission for the year ending June 30, 1906, contains some very interesting figures in connection with the railways in the United States. The report shows that the total single track railway mileage in the U. S. was 224,363 miles, an increase of 6,262 miles during the year. The number of corporations for which mileage is included in the report was 2,313.

The number of locomotives in service on June 30, 1906, was 51,672, an increase of 3,315. The total number of cars of all classes was 1,958,912, an increase of 116,041 for the year. The average number of locomotives per thousand miles of line was 232 as against 223 for the previous year. The average number of cars per thousand miles of line was 8,810 as compared with 8,494 for the previous year. The number of passenger miles per passenger locomotive was 2,055,309, an increase of 6,751 miles for the year. The number of ton miles per freight locomotive was 7,232,563, an increase of 541,863 ton miles.

The number of persons on the pay-rolls of the railways in the United States was 1,521,355, which is equivalent to 684 employees per 100 miles of line, a total increase of 139,159 persons or 47 per 100 miles of line. Of the employees nearly 60,000 were enginemen, 62,678 were firemen, nearly 44,000 were conductors and over 119,000 were other trainmen. Disregarding a small number not assigned the employees were grouped into four general divisions as follows: For general administration 57,054, an increase of 2,943. For maintenance of way and structures 495,879, an increase of 47,509. For maintenance of equipment 315,952, an increase of nearly 35,000. For conducting transportation 649,820, an increase of over 54,000. The total amount of wages and salaries paid to employees during the year was $900,801,653. This amount, however, is deficient more than $27,000,000 because of the loss of railway records at San Francisco.

The par value of railway capital outstanding was $14,570,421,478, which is equivalent to a capitalization of $67,936 per mile. Of the total capital stock outstanding 33.46 per cent. paid no dividends; during the previous year 36.17 per cent. paid no dividends. The amount of dividends declared during the year was equal to 6.03 per cent. on dividend paying stock. Figures for the previous year were 5.78 per cent.

The number of passengers carried during the year was 799,507,838, being 60,673,171 more than in the previous year. The number of passengers carried one mile was 25,175,480,383, the increase being about 1⅓ billion. The ton mileage was 215,877,551,241, the increase being nearly 29½ billion ton miles.

The number of ton miles per mile of line was 982,401, indicating an increase in the density of freight traffic of 121,005 ton miles per mile of line for the year. The average revenue per passenger per mile was 2.002 c.; the average for the preceding year being 1.962c. The average revenue per ton mile for freight was .748c.; the figure for the preceding year being .766c. The ratio of operating expenses to earnings for the year was 66.08 per cent.; the figure for the preceding year being 66.78.

The gross earnings per mile of line averaged $10,460, an increase of $862. The operating expenses averaged $6,912, an increase of $503. The net earnings per mile of line were thus $3,548. The figures for 1905 and 1904 were $3,189 and $2,998 respectively.

The total number of casualties to persons on the railways was 108,324, of which 10,618 were killed. Of the number killed 2,310 were trainmen, 147 switch tenders, etc., and 1,472 were other employees. The number of passengers killed during the year was 359 and the number injured 10,764. During the previous year 537 passengers were killed and 10,457 injured. Of these 146 passengers were killed and 6,053 injured because of collisions and derailments. The total of persons other than employees and passengers killed was 6,330; injured 10,241. One passenger was killed for every 2,227,041 carried and one injured for every 74,276 carried. Similar figures for 1905 were 1,375,856 and 70,655. One passenger was killed for every 70,126,686 passenger miles and one was injured for every 2,338,859 passenger miles.

STEAM MOTOR CAR.

INTERCOLONIAL RAILWAY.

The Intercolonial Railway of Canada is building three steam motor cars from designs drawn up in the office of the superintendent of motive power, one of which has recently been completed and put into service between St. John and Hampton, N. B.

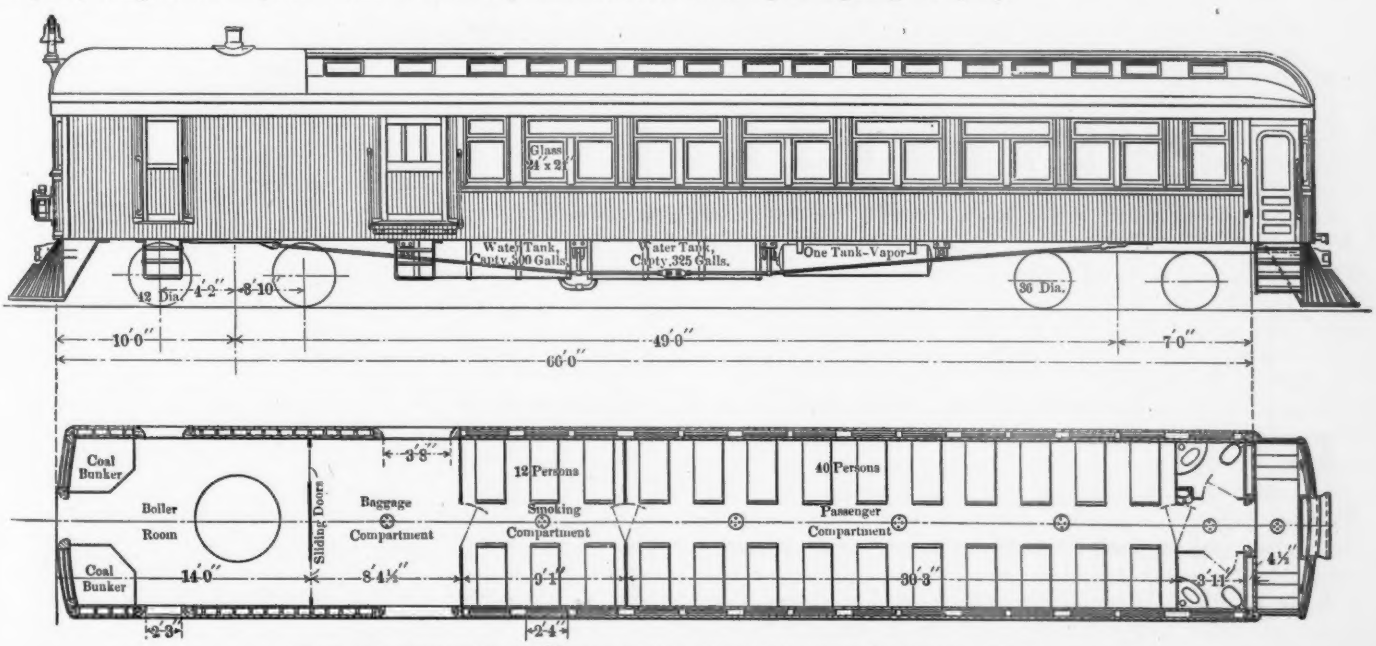
These cars are somewhat similar to other steam motor cars put into service in this country and consist of a small four-wheel locomotive carrying a vertical boiler, which forms one of the trucks of a passenger coach, the other truck being of the ordinary type. The cars in this case measure 66 ft. over end sills and weigh about 142,000 lbs. fully equipped and loaded. The locomotive is capable of developing about 200 h.p. and gives a tractive effort of 8,500 lbs. It is designed to give a speed of 25 miles per hour on a 1 per cent. grade. Coal is used for fuel, there being two bunkers giving a combined coal carrying capacity of one ton.

The car body in general follows the design and arrangement of the first-class coaches in use on that road. It is of wooden construction, having eight longitudinal sills, four of which are 4½ x 8 in., two being 5 x 8 in. and side sills 5 x 8¾ in. The superstructure is of the ordinary type for a heavy wooden passenger coach, with the exception of a short distance at the motor end where the roof is made of sheet iron and curved from plate to plate, being bolted in place. This is done to permit the roof to be easily removed when it is desired to take out the boiler. The cars are intended to run in either direction, with or without trailer, and are equipped with a pilot and M. C. B. coupler at both ends. They are also equipped with through piping and hose connections for both steam heat and air brakes.

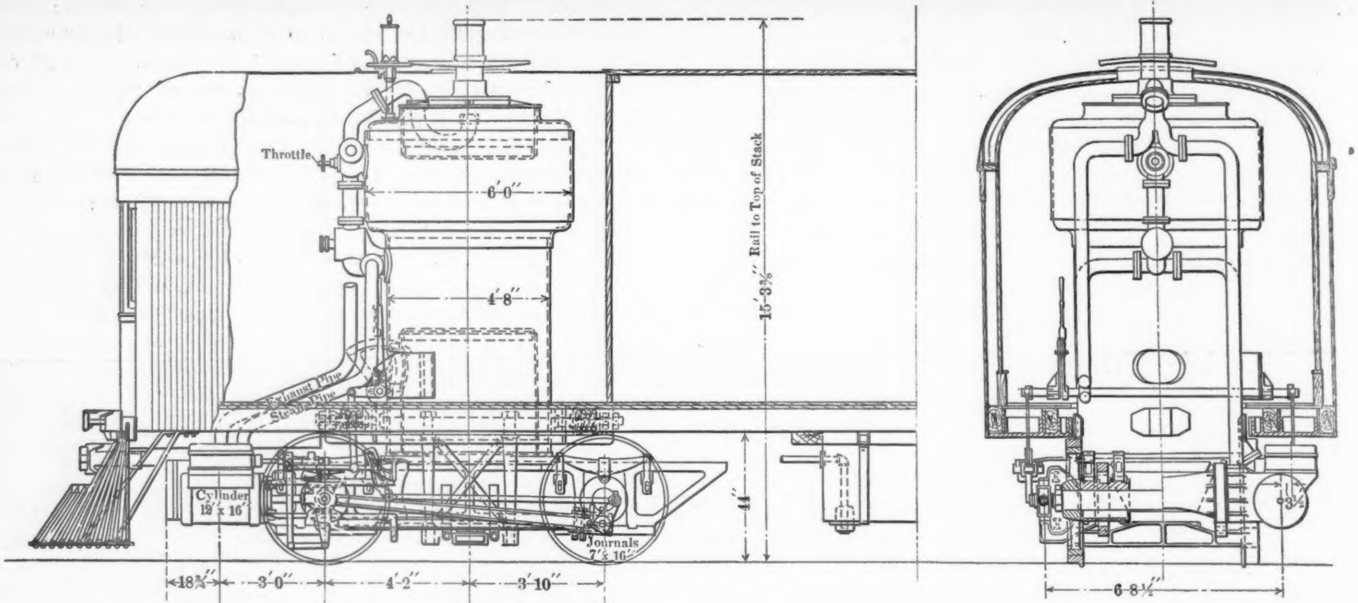
They are fitted with steel platforms at either end, the one at the motor end, however, being included in the boiler room and cab space. The boiler room is fitted with sliding side doors, which are set some distance back from the ends of the car. It measures 13 ft. 6 in. long inside and contains the boiler, its attachments and all operating gear, as well as a 9½ in. pump, coal bunker, etc. This adjoins a baggage compartment of 8 ft. 4½ in., which is fitted with two sliding side doors, there also being two doorways leading to the boiler room and a door to the smoking compartment, which immediately adjoins it. The smoking compartment has a seating capacity of twelve persons and is separated from the regular passenger compartment by a partition. The passenger compartment has a seating capacity of forty persons, and is fitted out in the same manner as a first-class day coach. The vestibule at the rear end of the car is somewhat longer than the ordinary standard, in order to give space for the controlling equipment at this end. An engineer's brake valve, a throttle closing device, whistle and bell cords, etc., are installed at this point, being arranged so as to give an unobstructed passage when the car is being operated from the opposite end.

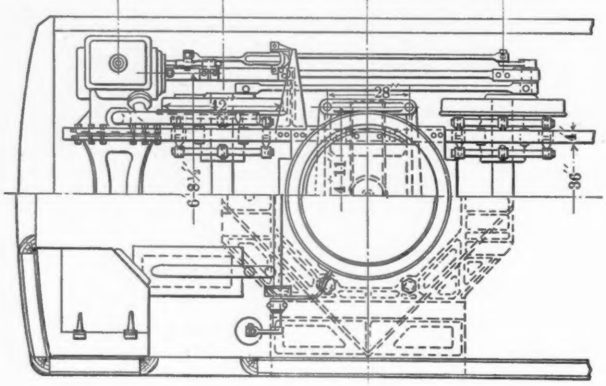
The cars are heated with steam and lighted by incandescent mantle lamps, using the new vapor system of the Safety Car Heating & Lighting Company.

STEAM MOTOR CAR, INTERCOLONIAL RAILWAY.



PLAN AND ELEVATION OF 66-FOOT STEAM MOTOR CAR, INTERCOLONIAL RAILWAY.





GENERAL ARRANGEMENT OF MOTOR TRUCK, STEAM MOTOR CAR.

The locomotive truck consists of wrought iron bar frames, 4 x 3 in. in section for the top rail, fitted with pedestals, shoes and wedges, binders, etc., in the usual manner, and having an extension on the forward end to which are bolted the 12 x 16 in. cylinders. A rigid steel casting is secured between the extensions of the frames to give stiffness. The drivers are 42 in. in diameter and have a wheel base of 8 ft. They are coupled together by a side rod and the main crank pin is on the rear driver. Balanced slide valves operated by Walschaert valve gear are used. The drivers are not equalized, each supporting a separate pair of semi-elliptic springs, there being one on either side of the locomotive frame over each journal box. All driving journals are 7 x 16 in.

The boiler, a section of which is shown in one of the illustrations, is of the vertical type, and carries a pressure of 180 lbs. per square inch. It contains 361 1½-in. copper tubes, giving a heating surface of 684.7 sq. ft. The firebox has a heating surface of about 44 sq. ft., giving a total heating surface for the boiler of 728.7 sq. ft. The grate area is 11.5 sq. ft. Steam is taken from the top of the steam drum and is somewhat superheated by the 6 in. length of tubes, which project above the water level. The boiler is carried on top of the frames by a heavy steel casting fitted and bolted to both the frames and bottom of the boiler. The exhaust steam from the cylinders is carried to the stack. The piping connections and arrangement, as well as the general design of the locomotive truck, is shown in one of the illustrations.

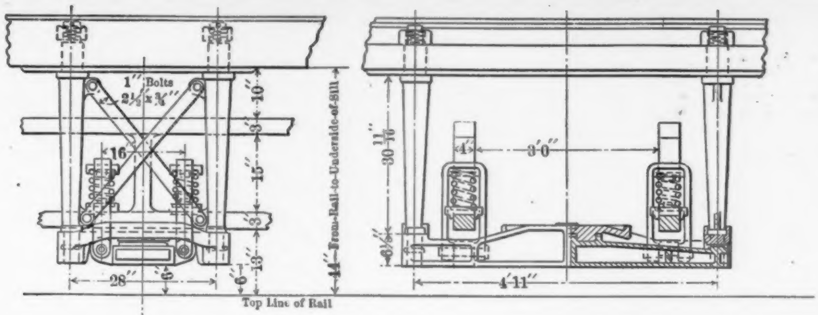
The method of supporting the car body upon the motor truck has been solved in a very satisfactory manner. Since the boiler must project up through the car body and must necessarily be rigid with the motor truck and since, further, the motor truck must be capable of free movement in relation to the car body, it was necessary to design a special form of support. This has been done by the use of a large cast steel body bolster, which weighs about 4,430 lbs., and has a large opening in the center through which the boiler passes. This casting is securely fastened to the underframe of the car body and carries four heavy steel struts which connect to another cast steel bolster passing across below the ash pan of the boiler.

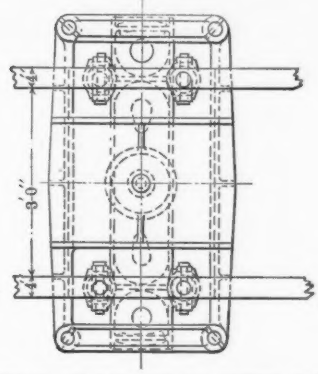
This bolster takes a bearing through a center plate on another steel casting, or truck bolster, which is hung from the engine frame by means of four wrought iron hangers fitted with equalizing springs. These springs rest in cup-shaped caps and seats, and allow the car body to take the different relative positions necessary when rounding curves. Buffing springs are arranged between the body bolster and the boiler to prevent any jarring when the car is in motion. This construction is clearly shown in the illustrations.

The water supply is carried in tanks suspended from the underframe, which have a combined capacity of 1,000 Imperial gallons. The boiler is fed by two Hancock inspirators.

The general dimensions of the car and its motor are shown in the following table:

MOTOR TRUCK AND BOILER, INTERCOLONIAL MOTOR CAR.





DETAIL OF SUPPORT ON MOTOR TRUCK.

CAR BODY.

Seating capacity	52 persons
Gauge of track	4' 8½"
Length over end sills	66' 0"
Width over side sills	9' 10"
Height, top of sills to under side of plate	6' 7¼"
Length, inside sheathing	65' 1⅜"
Width, inside sheathing	8' 11⅜"
Width, between deck rails	4' 10"
Height, inside, top of floor to under side of lower deck rail	7' 7¾"

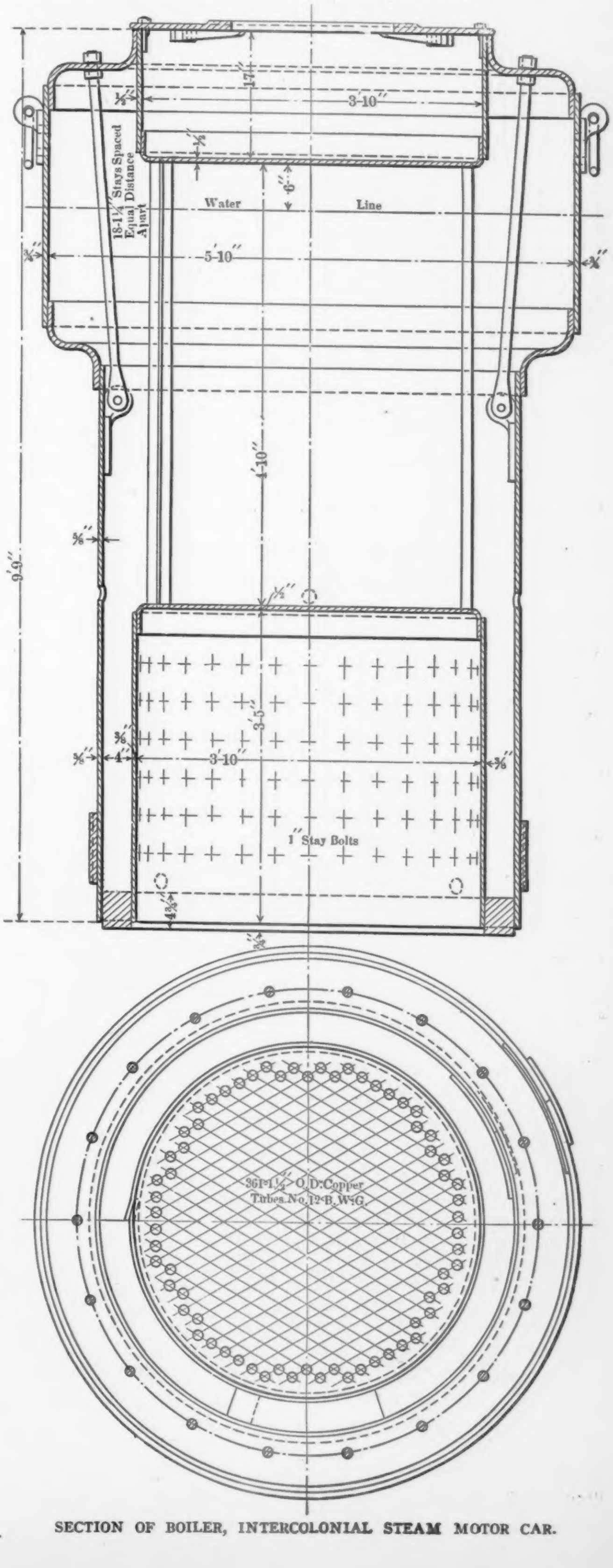
MOTOR TRUCK.

Cylinders	12" x 16"
Gauge	4' 8½"
Driving wheels	42" diam.
Wheel base of engine	8' 0"
Heating surface in tubes	684.672 sq. ft.
Heating surface in firebox	44.04 sq. ft.
Total	728.712 sq. ft.
Grate area	11.54 sq. ft.
Working pressure	180 lbs. per sq. in.
Test	250 lbs. per sq. in.
Weight of motor (without car)	51,000 lbs.
Total weight of motor and car loaded	142,000 lbs.
Tractive effort	8,500 lbs.
Horse power of engine, about	200
Speed on 1% grade	25 miles
Motor to haul a trailer of	40 tons

TRAIN LIGHTING IN GERMANY.—For some time past the authorities of the German State Railways have been experimenting with the incandescent gas light for illuminating their railway carriages, and the compartments of the "Stadtbahn" have been equipped with burners of the inverted type. The mantles, which, in railway traffic are continually subjected to shocks and vibration, have nevertheless proved to be quite durable, so that they can be used for several months. The cost of the incandescent mantles average about 5d. It has been found that pure oil gas is cheaper and gives better results than the mixture of three parts oil gas and one part acetylene, which was introduced several years ago. The experiments have proved that the inverted incandescent gas light is far cheaper, and gives at the same time a much better light than the flame system hitherto employed. The authorities of the German State Railways have therefore decided to introduce the inverted incandescent gas light throughout the whole railway system. This great change, which can, of course, only be carried out gradually, is expected to take two years.—*The Engineer (London)*.

NUMBER OF MALLET COMPOUND LOCOMOTIVES IN THE U. S.—There are at present 50 Mallet articulated compound locomotives in service in this country, of which one is on the Baltimore & Ohio Railroad in pushing service; five are on the Great Northern Railway in pushing service; sixteen on the Northern Pacific in pushing service; twenty-five on the Great Northern Railway in road service and three are in pushing service on the Erie Railroad. All but one of these locomotives have been built during the past two years and most of them during the past year.

RAILROAD SCHOOL FOR TELEGRAPHY.—The Pennsylvania Railroad has organized a school of telegraphy at Bedford, Pa., where it will train men for this branch of its service. The men will not only be trained in telegraphy, but will also be instructed in the general duties of station agents. The time required to complete the course will be from six to eight months and a tuition fee of $2.00 per month will be charged. Immediately upon graduation the men are provided with salaried positions in direct line of promotion.



SECTION OF BOILER, INTERCOLONIAL STEAM MOTOR CAR.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

J. S. BONSALL,
Business Manager.
140 NASSAU STREET, NEW YORK

R. V. WRIGHT,
E. A. AVERILL, Editors.

SEPTEMBER, 1907

Subscriptions.—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union.*
Remit by Express Money Order, Draft or Post Office Order.
Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburg, Pa.
Century News Co., 6 Third St., S. Minneapolis, Minn.
W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of owcial changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.*

CONTENTS

The variable speed motor may be used to splendid advantage in connection with many of the machine tools in railroad repair shops and its usefulness in that field will undoubtedly be still further extended. It is quite noticeable, however, that a number of lines of machine tools have been equipped with mechanical speed changing devices during the past year or two, which furnish about all the speed changes that can be used to advantage, and are giving successful service when used in connection with constant speed motor or belt drives.

The method of plotting a combination diagram, consisting of a series of curves which cover the whole range of operation of a locomotive, as described by Mr. Lawford H. Fry on another page, is of special interest. Such a diagram can be drawn for any particular size of locomotive to show the coal and water consumption directly in pounds per hour, the tractive force in pounds and the speed in miles per hour. With the aid of a chart of this kind the operating officer can see at a glance the effect which any change in speed or loading will have on the economy of operation.

A paper presented at the last meeting of the New York Railroad Club on "The Steam versus the Electric Locomotive" by Mr. Max Toltz, discusses the improvement possible in the operation of the present American steam locomotive. It is somewhat in the nature of a reply to the paper presented before the American Institute of Electrical Engineers last January, which gave detail figures to prove that a saving of $250,000,000 could be made in the cost of operation of our railways by substituting electricity for steam as a motive power. It shows that approximately an equal saving could be made with a much less capital charge by the application of three devices to the present steam locomotives. These are the superheater, feed water heater and automatic stoker. The first two are credited with a capacity for saving 20 per cent. each, and the stoker with 5 per cent., or an aggregate of 39.2 per cent. for the three. This saving in fuel, it is claimed, will be accompanied by a 30 per cent. reduction in the number of engine and roundhouse men and a 30 per cent. saving in the cost of water supply.

The following extract, concerning an editorial in our September issue entitled "The Successful Motive Power Department Official," is taken from a communication received from one who has been eminently successful in charge of a motive power department

"The essence of the whole thing is to provide definite measures with which to compare every man and every detail of business, in so far as it is possible to do so. The measuring stick from the standpoint of the manager must be definite and accurate. The measuring stick from the standpoint of the employe who is being measured, should impress him as being absolutely fair and that to whatever extent he is compared with the standard, his relative efficiency is due entirely to his own good or bad performance. The above may seem so self-evident that it is not worth while to emphasize them, but my experience has been that most people who are trying to accomplish results are liable to lose sight of the essential principles and unless they keep them before them constantly, their results are quite likely to be disappointing."

The article in this issue concerning the New York Central Lines apprentice system is the most important one of the series, as it presents a detail study of the purely educational part of the work. One reason why so many apprentice systems have failed is that this feature has not been arranged to meet the needs of the apprentice in a practical way. The New York Central Lines method is eminently practical and while it is only in the process of being developed, the results which have been gained during the past year or more, in which it has been in operation, are very satisfactory. With this in mind we have thought it necessary to go into the drawing and problem courses in considerable detail, in spite of the fact that other important articles have had to be held over until our next issue, in order to make room for it.

* * * * * * * *

The apprentice instructors of the New York Central Lines

held their first annual conference at the Collinwood shops on September 18 and 19. An idea of the extent and importance of this meeting may be gained from the fact that over forty topics were considered, all of practical importance. We expect to present an abstract of the proceedings of this conference in our November issue, thus completing and rounding out the description we have been presenting of the apprentice system.

* * * * * * *

The Santa Fe is establishing an apprentice system, on a large scale, somewhat similar to that on the New York Central Lines. Mr. F. W. Thomas, formerly engineer of tests, has been placed in charge, with the title of supervisor of apprentices. The first school has already been started at the Topeka shops. Mr. C. M. Davis, formerly drawing instructor of the apprentice school at the Brightwood shops of the Big Four, has been secured to assist in this work. It will be recalled that Mr. Harrington Emerson in discussing the apprentice question at the recent meeting of the Master Mechanics' Association presented some interesting figures concerning the efficiency of the apprentices in the Topeka shops. It will be interesting to check this with comparative figures after the new system has become well established. Those who are familiar with the interest which Mr. John Purcell, the shop superintendent at Topeka, has always taken in the apprentices in his organization will realize that his hearty co-operation will be given in developing and perfecting this work at Topeka. As soon as it has been well started at that point it will be extended to the other shops on the system and thus, although they will, of course, not have any connection with the New York Central system, a line of practical apprentice schools will extend across the continent. Several other large railroads have the question of establishing similar apprentice systems under consideration.

We are fortunate in being able to present, in this issue, an article on "Shop Efficiency," by Mr. H. W. Jacobs. It goes somewhat more into detal as to the method of determining the exact efficiency of the individual worker, gangs, or shops as a whole, than was possible in the paper presented at the recent meeting of the Master Mechanics' Association by Mr. A. Lovell on "Shop Cost Systems" (July issue, page 274), or in the article in our June issue, page 221, by Mr. Harrington Emerson on "The Methods of Exact Measurement Applied to Individual and Shop Efficiency at the Topeka Shops," or in the article by Mr. J. F. Whiteford in our June issue, page 216, on "Roundhouse Betterment Work." This matter of calculating the exact efficiency of the individual or shop was one of the later developments (and one of the most important) of the betterment work. To set a standard time for a piece of work, or to determine a reasonable cost for a certain operation or the maintenance of a piece of equipment, and then to encourage the men to strive to reach it, is the key to the best work which has been done along betterment lines in our mechanical departments.

* * * * * * *

An important feature of the betterment work on the Santa Fe is that just as soon as possible the betterment department was merged into the regular mechanical department organization. At the present time four men, each having general supervision of the betterment work on a division, report directly to the assistant superintendent of motive power, Mr. H. W. Jacobs. These men are Mr. J. L. Sydnor, on the Coast Lines; Mr. C. J. Drury, on the Western Grand Division; Mr. E. E. Arison, on the Eastern Grand Division, and Mr. J. E. Epler, on the Gulf Lines. In addition to these Mr. Raffe Emerson assists Mr. Jacobs and Mr. J. F. Whiteford has general supervision of roundhouse work over the entire system. Bonus supervisors are located at each point. Mr. Clive Hastings handles statistical matters in connection with the betterment work and reports directly to the 2nd Vice-president, Mr. J. W. Kendrick.

* * * * * * *

We have had so many requests for the special article on betterment work on the Santa Fe, published in our December, 1906, issue, and for other articles which have since appeared concerning the later developments, that it has been suggested that a list of all the articles touching on this work, which have appeared in our journal, be published. These are as follows:

"Shop Betterment and the Individual Effort Method of Profit Sharing," by Harrington Emerson. (A reprint of a pamphlet which was prepared for distribution among the workmen on the Santa Fe.)—Feb., '06, page 61.

"Locomotive Repair Schedules," by C. J. Morrison. (A detailed description of the schedules in use at the Topeka shops.)—Sept., '06, page 338.

"The Surcharge Problem," by C. J. Morrison. (A description of the method of determining surcharges and how they are applied.)—Oct., '06, page 376.

The above article excited considerable discussion and communications concerning it were published on page 438 of the Nov., '06, issue, and 478 of the Dec., '06, issue, Mr. Morrison going into greater detail as to the exact methods of determining the surcharge on page 479. Other communications appeared on page 64 of the Feb., '07, issue.

"Betterment Work on the Santa Fe." (A complete study of the development of this work and the general and specific results which had been obtained to date. The article covered 26 pages.)—Dec., '06, page 451.

Communications concerning the above article appeared in the Feb., '07, issue, page 63, and March, '07, page 102.

"Dispatching Board for Engine Repairs," by C. J. Morrison.—Apr., '07, page 131.

"Roundhouse Betterment Work," by J. E. Whitford.—June, '07, page 216.

"The Methods of Exact Measurement Applied to Individual and Shop Efficiencies at the Topeka Shops," by Harrington Emerson.—June, '07, page 221.

Communications concerning the above article appeared on pages 287 of the July, '07, issue, and 308 of the August issue.

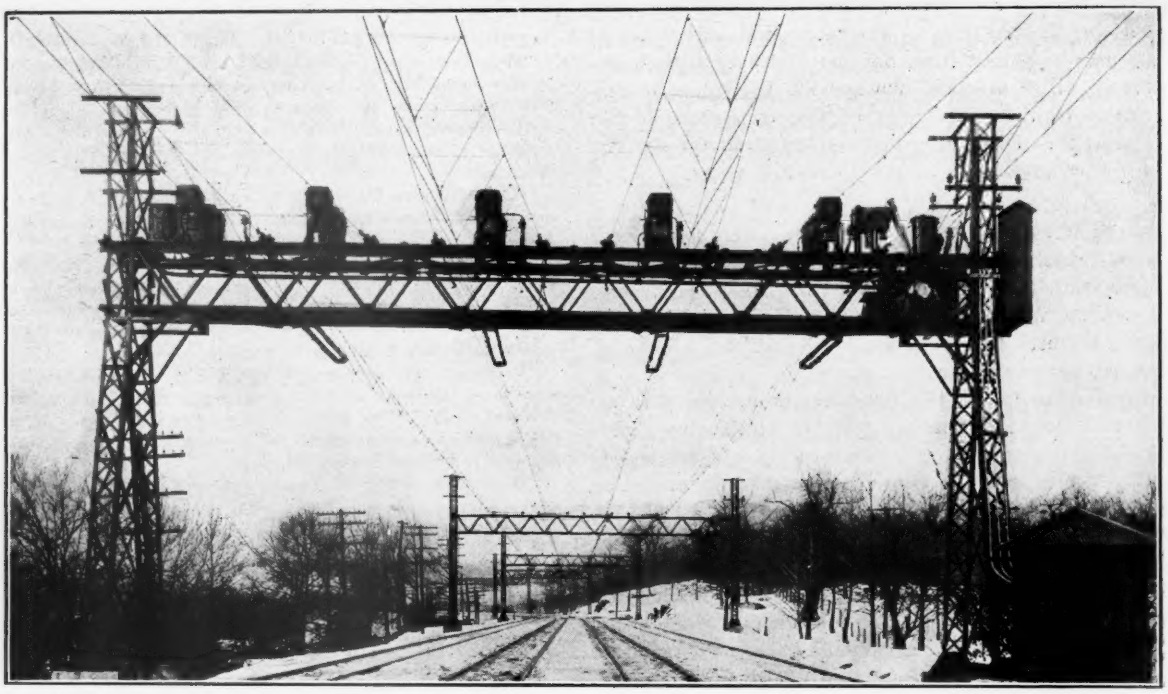
"Shop Cost Systems and the Effect of Shop Schedules Upon Output and Cost of Locomotive Repairs," by A. Lovell. (A reprint of a paper presented before the Master Mechanics' Association and an abstract of the discussion.—July, '07, page 274.

"Shop Efficiency," by H. W. Jacobs.—In this issue.

Editorial comments on the betterment work on the Santa Fe appeared on page 478 of the Dec., '06, issue; page 20 of the Jan., '07, issue, and page 231 of the June, '07, issue.

Occasionally we meet readers who in the course of conversation may remark that in a previous issue they noticed certain articles, or statements, with which they could not agree. When asked why they did not write a letter drawing our attention to it, they usually reply that they did not want to be drawn into a controversy, or did not care to criticise the work of the author. This is an entirely wrong attitude. We don't expect our readers to "swallow everything whole" that appears in this journal. Our aim is, as it has been in the past, to do our utmost to assist in upbuilding the motive power department and placing it on the high plane which its importance deserves. We try to bring out the best practices in vogue and to keep our readers informed as to all of the important developments which take place affecting that department. It is true, however, that what may prove best under one set of conditions may be entirely inadequate for others. Our desire is not so much to present material which can be applied directly by our readers as to set them thinking so that they can not only make intelligent use of what the other fellow is doing, but improve upon it if possible.

We use every precaution to have our facts and statements exact and clearly stated and if they don't agree with your beliefs or experiences we shall be only too glad to have you write and give us your views. There is nothing of greater assistance, or inspiration to an editor, than frank criticism, whether adverse or favorable. In the last three issues we presented two contributed articles containing some rather radical statements which the authors expected to have severely criticised. As a matter of fact the articles were published with the idea of stirring our readers up to make them think along certain important lines. It is true that they were criticised, but not as much as we would have liked to have had them. We want you to tell us frankly when you notice statements which you think are wrong, or with which you cannot agree; it will assist us greatly. We never publish communications without first asking the permission of the writer, and some which have helped us most have not been published at all. When for any good reason it is not thought advisable to use the writer's name the communication may appear over an assumed name, but the editors of course must know the writer's real name. Remember that this paper is published to meet your needs and that its success will be proportional to the degree in which it accomplishes this.



VIEW SHOWING ANCHOR BRIDGE AND OVERHEAD CONSTRUCTION—NEW YORK, NEW HAVEN & HARTFORD RY.

HEAVY ELECTRIC TRACTION ON THE NEW YORK, NEW HAVEN & HARTFORD RAILWAY.

On page 362 of the September issue of this journal will be found an article by Mr. E. H. McHenry, vice-president of the New York, New Haven & Hartford Railway, setting forth the causes leading up to the electrification of that system from Woodlawn, N. Y., where it joins the New York & Harlem Railroad, to Stamford, Conn., a distance of 21 miles. In the same article were given the reasons for adopting the alternating current system for power and some comments on the broad commercial aspect of electric traction for steam railways.

The present article will briefly describe some of the most interesting features of the novel overhead structure for conveying the power to the trains and the electric locomotives which are in use on the electrified section, and will be followed by an article describing the equipment of the Cos Cobb power house, where all of the current for the present installation is generated.

One of the chief advantages of the use of alternating current is that a high voltage may be used in the supply system. This necessarily compels great care in the matter of insulation and demands that the supply current be furnished from an overhead conductor instead of the third rail. Such an overhead system must necessarily be of the most substantial construction in every part. In the present instance a potential of 11,000 volts is furnished by the overhead conductor, which is supported over the center of the track by the so-called double catenary system. This system consists of two steel cables of specially high strength supported at intervals by steel bridge structures, and a copper conductor suspended from these two cables by means of hangers placed at frequent intervals. Wherever the cables pass over the steel supporting bridges they rest on massive porcelain insulators and at frequent intervals heavy bridges are provided against which the cables are anchored by means of specially constructed strain insulators.

The steel supporting bridges are of varying lengths, so as to accommodate from four to twelve tracks, as conditions may require, without the necessity of placing posts between the tracks. The bridges are of uniform design and consist of angle iron lattice bar construction. The intermediate bridges are of lighter construction than the anchor bridges, which are used at intervals of about two miles. The former have side posts of square cross section and comparatively light structure; while the anchor bridges have A-shaped posts and are made much heavier, to withstand the strain of the cables.

The anchor bridges are provided with automatic circuit breakers, by means of which the different sections of line may be isolated. They also carry lightning arresters and shunt transformers, for operating the circuit breakers.

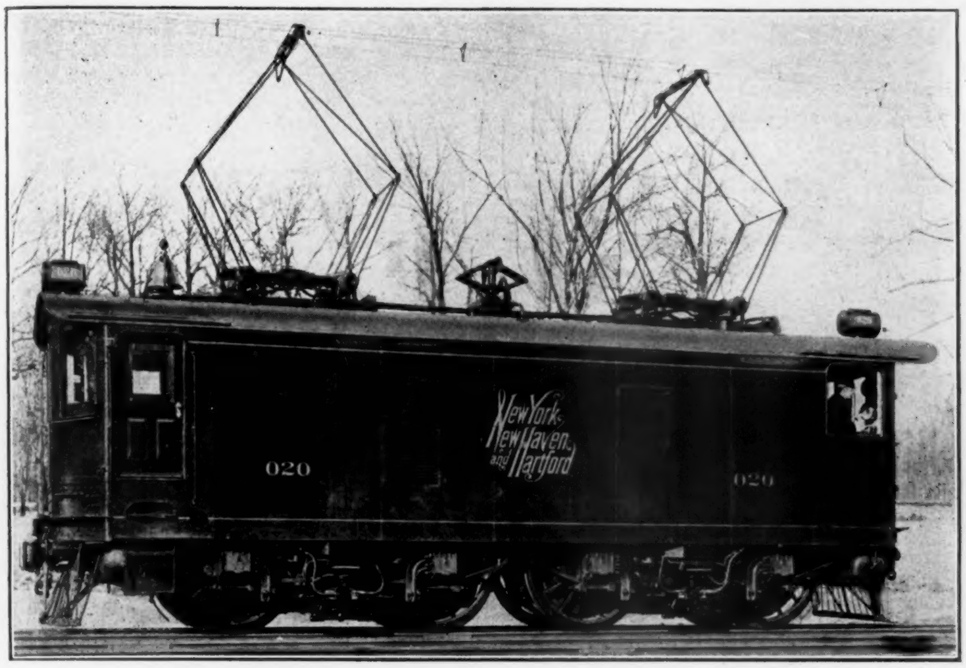
The main conductors over the running tracks are paralleled throughout their entire length by two feeder wires. These feeders constitute auxiliaries to the main track conductors and are connected to them at each anchor bridge through circuit breakers, thus providing the means for feeding around any particular section in case it is desirable to cut it out of service. There are also two other feeder wires, called power feeders, carried throughout the length of the line. These are connected to the third phase of the generating system and are used for operating the three phase apparatus at certain points on the road. Provision is also made on the bridges for carrying two other three phase circuits.

In laying out the bridges it was found that the sharpest curvature on the line was 3 degs. and this curvature will permit the stringing of the trolley wire in straight lines between points of support 150 ft. apart without deviating from the center of the track more than 8½ in. on each side. It was thus decided to place the bridges a fixed distance of 300 ft. apart and on the sharper curves to provide intermediate single poles from which pull over wires are carried to the catenary spans.

Intermediate Bridges.—The supporting posts of the intermediate bridges are approximately 38 ft. long by 1 ft. 10 in. square. Each is composed of 4 x 4 x 7/16 in. angles secured together by 2¼ x ⅜ in. lacing bars. They rest on foundations of concrete, each being secured by anchor bolts extending through the foundations. The cross truss is attached to the vertical posts by bolts and allows a clearance of 23 ft. 4 in. from the lower side of the truss to the top of the rails. The truss is 4 ft. 6 in. deep and 1 ft. 10 in. wide, the upper chord angles being 3½ x 6 x ⅜ in. and the lower 4 x 3½ x 5/16 in.

In the calculations of these bridges, very heavy weather conditions were assumed and provision was made for clamping the catenary cables on the intermediate bridges, so that they would be able to assist somewhat in withstanding the longitudinal pull. It was assumed that the entire system of bridges and cables might become coated with sleet and that this coating might be ½ in. in thickness around all surfaces. Under these conditions it was further assumed that the wind pressure on the bridges and catenary spans might be as high as 25 lbs. per sq. ft. The truss is also made strong enough, to prevent its buckling under the strain produced by the breakage of any pair of cables.

Anchor Bridges.—One of the illustrations shows an anchor bridge in the foreground and an intermediate bridge in the back-



SINGLE-PHASE LOCOMOTIVE—NEW YORK, NEW HAVEN & HARTFORD RAILWAY.

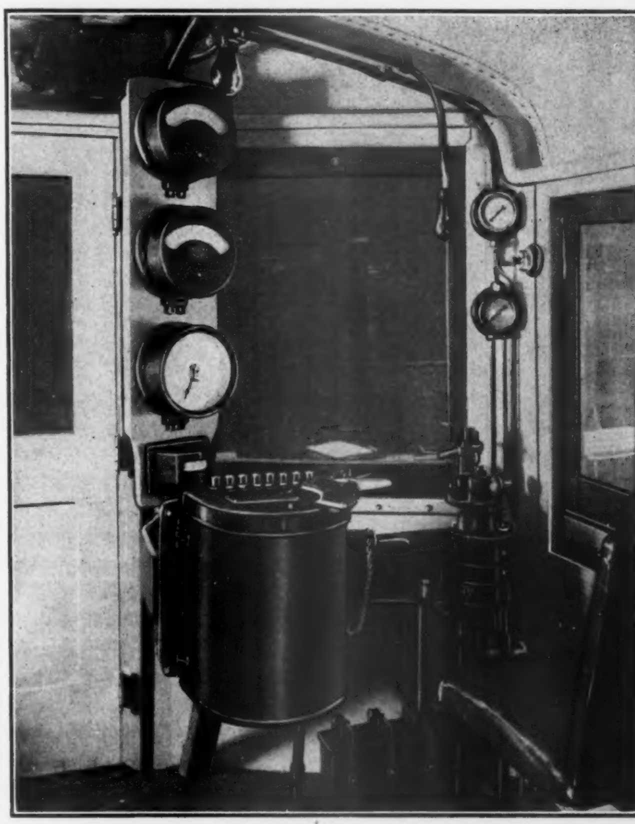
ground. The former are placed about two miles apart and consist of two A-shaped posts having a spread of 15 ft. at the base and a width of about 2 ft. The main members of the post consist of 6 x 4 x ⅝ in. angles. The truss across the tracks allows a clearance of 24 ft. 3 in. and is 4 ft. 6 in deep and 5 ft. wide, the upper chords consisting of 8 x 8 x 9/16 in. angles and the lower chords 4 x 3½ x 9/16 in. angles. Each anchor bridge has a ladder on one of the posts leading to a small platform at the end of the truss. This platform is provided with a hand rail and carries upon it a box containing a 11,000 volt low equivalent lightning arrester. A platform is built along the lower chord of the truss from which access to the block signals (not shown in the illustration) is provided by short ladders and also by other ladders to a platform upon the upper chord. This upper platform is surrounded by a hand rail to which are attached the supporting frames of the circuit breakers. The arrangement and connections are such that an attendant cannot in any way come in contact with live parts of the circuit.

Catenary Cables.—Each of the two catenary cables which support the copper conductor consists of an extra high strength steel cable 9/16 in. in diameter and made up of several heavy strands. The steel in each strand has an ultimate strength of 200,000 lbs. per sq. in. and each strand is heavily galvanized. The complete cable has a strength of 33,800 lbs. The cables are strung between the bridges with a sag of 6 ft. at mean temperature and are dead ended and anchored at each anchor bridge through specially constructed insulators designed to stand an electric test of 50,000 volts and a working load of 20,000 lbs.

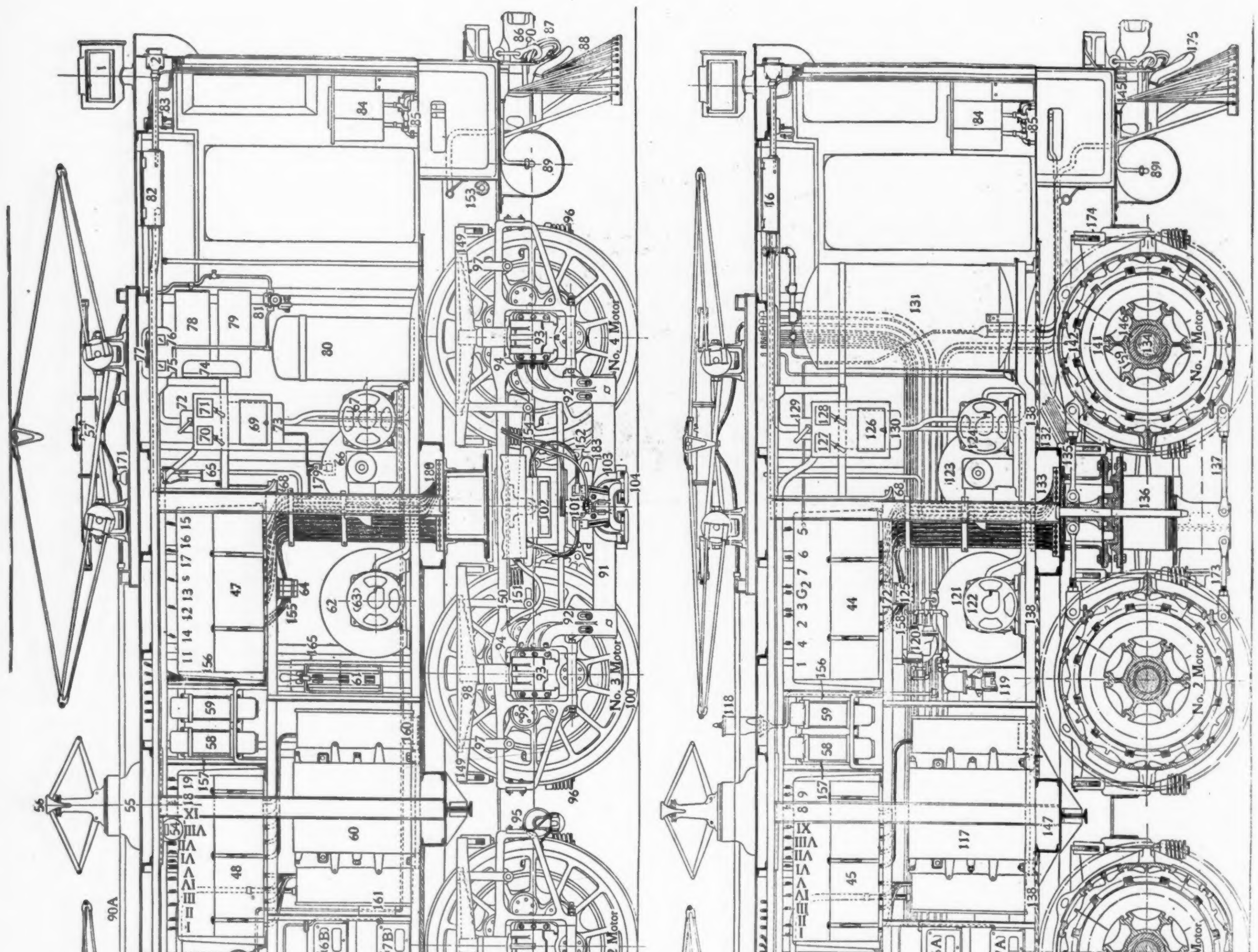
The conductor wire or trolley is supported from the catenary cables by means of triangular hangers of varying lengths, spaced 10 ft. apart. These hangers are so adjusted in length that the trolley wire is maintained in a horizontal position, being 6 in. below the cables at the middle point of the span. The hangers consist of a pair of drop forged steel jams which engage the groove of the wire and are clamped by means of a malleable iron Y, screwed down upon the threaded portions of the jams. The sides of the triangle are then screwed into the Y and are bolted into the catenary cables above. A spacing piece the same length as the hangers completes the triangle.

At each anchor bridge it is necessary to provide an insulator in the trolley wire. This insulator is the piece of apparatus shown beneath the bridge in the illustration and consists of two bronze end castings to which the ends of the wire are bolted. Two parallel sections of impregnated hard wood are fastened to these castings and to the lower sides of these wooden strips are secured renewable pieces of copper wire, the wire on each piece extending somewhat beyond the center, and thus permitting the sliding contact of the locomotive to pass from one section to the next without opening the circuit.

Circuit Breakers.—The type of circuit breakers which has been developed for this installation consists of a cast iron framework adapted for bolting to the railing of the anchor bridges, which carries an iron box provided with a hinged cover. This cover is arranged to fit tightly and be entirely weatherproof. The moving parts of the circuit breaker are contained within this box and are made especially strong and reliable in their operation. Arrangements are provided so that when the cover of the box is opened the breaker will be automatically tripped and prevent any possibility of an attendant taking hold of live parts. A tripping coil is provided and also closing magnets, both of which are operated from a circuit supplied from the shunt transformers on the anchor bridge. This circuit is carried in an iron conduit to the adjoining signal tower where a switchboard is provided and fitted with switches so that any circuit breaker may be tripped or closed by the attendant in the signal tower. The breaker is also arranged to open automatically on an overload. The auxiliary feeder wires are looped into the bus bars on each alternate anchor bridge. These connections are made through automatic circuit breakers, so that in case of the grounding of the bus bar structure of any bridge one of the auxiliary feeders will pass around the grounded bridge to the next section beyond. On each anchor bridge one auxiliary feeder is broken by a strain insulator and connections are made through a circuit breaker to the bus bar. The other feeder is carried directly through and a single tap connection is made from the



INTERIOR OF CAB AT MOTORMAN'S STATION—NEW HAVEN ELECTRIC LOCOMOTIVE.



SECTIONS SHOWING ARRANGEMENT OF APPARATUS ON BOTH SIDES OF NEW HAVEN ELECTRIC LOCOMOTIVE.

1. Headlight.
2. Train Line Receptacles, Type 444 D-E and F.
3. Instrument Board.
4. Speed Indicator Meter.
5. D. C. Ammeter Motors.
6. A. C. Ammeter Motors.
7. Temperature Indicator Meter.
8. Equalizing Reservoir Air Brake.
9. No. 1 Master Controller.
10. No. 1 Automatic Motorman's Brake Valve.
11. No. 1 Independent Brake Valve.
12. Duplex Gage Main Res. and Train Line.
13. Whistle Handle.
14. Straight Air-Brake Gage.
15. Three-Way Snap Switch in Light Circuit.
16. No. 1 Junction Box.
17. Motorman's Seat.
18. No. 1 A. C. Pantograph Trolley.
19. No. 2 Oil Circuit-Breaker.
20. Overload Trip.
21. Oil Tank on Circuit Breaker.
22. Insulators for Pantograph Trolley.
23. Support for A. C. Trolley.
24. High-Tension Cable from A. C. Trolleys.
25. A. C. Trolley Shoe.
26. A. C. Trolley Lock Cylinder.
27. Steam-Heating Boiler.
28. Gage—Air Pressure on Burner.
29. Water Gage.
30. Drain Cup.
31. Try Cocks.
32. Fire Door.
33. Burner.
34. Gold Car Co. Regulating Valve.
35. Mason Regulating Valve.
36. Steam Line from Boiler.
37. Air Inlet to Fire-Box.
38. Water Feed Regulator.
39. Hand Brake Wheel.
40. Steam Gage.
41. Safety Valve.
42. Stack for Boiler.
43. H. T. Conduit from Oil Switch to Transformer.
44. Switch Group No. 1.
45. Switch Group No. 2.
46. Switch Group No. 3.
47. Switch Group No. 4.
48. Switch Group No. 5.
49. Switch Group No. 6.
50. Motor Generator Set for Battery Charging.
51. Base for Motor Generator Set.
52. Storage Battery.
53. No. 2 Set of Resistance Grids.
54. A. C. Integrating Wattmeter.
55. Base for D. C. Trolley.
56. D. C. Trolley.
57. No. a A. C. Pantograph Trolley.
58. Preventive Coil, 100 Volts, 250 Amps.
59. Preventive Coil, 50 Volts, 500 Amps.
60. No. 2 Transformer.
61. Main D. C. Switch.
62. No. 2 Blower Motor Fan Casing.
63. No. 2 Blower Motor.
64. Permanent D. C. Field Shunting Grid No. 2.
65. Hand Air Pump for Unlocking A. C. Trolley.
66. No. 2 Air Compressor.
67. No. 2 Air Compressor Motor.
68. Magnet Valves.
69. No. 2 Fuse Box.
70. Canopy Switch for No. 2 Blower Motor.
71. Canopy Switch for No. 2 Compressor Motor.
72. No. 2 Motor Control Cut-out.
73. No. 2 A. C., D. C. Change-Over Switch.
74. Relay Box.
75. Snap Switch for Cab Lights.
76. Snap Switch for Headlights.
77. S. P., D. T. Switch Light Circuit.
78. Control Reservoir.
79. Cover for Resistance Grid.
80. Oil Tank.
81. Slide Valve Reducing Valve.
82. No. 2 Junction Box.
83. Signal Valve.
84. Sand Box.
85. Electro-Pneumatic Sander.
86. Coupler.
87. Hose Couplings.
88. Pilot.
89. Main Air Reservoir.
90. Hook for Safety Chains.
90-A. Cable Connecting A. C. Trolleys.
90-B. No. 2 Master Controller.
90-C. No. 2 Automatic Brake Valve.
91. Third-Rail Shoe Beams.
92. Third Rail Shoe Bracket.
93. Journal Box.
94. Truck Frames.
95. Magneto for Speed Indicator.
96. Motor Suspension Springs.
97. Spring Hanger.
98. Elliptical Springs.
99. Wheel Pocket Cover.
100. Main Driving Wheel.
101. Third-Rail Shoe Cylinder.
102. Third-Rail Shoe Fuse Box.
103. Main Casting for Third-Rail Shoe.
104. Third-Rail Shoe.
105. Bell.
106. A. C., D. C. Change-Over Switch Heater Circuit.
107. Fuse Box, Heater Circuit.
108. Governor Valve for Emergency Control Reservoir
109. Three-Way Cock Emergency Control Reservoir.
110. Emergency Control Reservoir.
111. Slide Valve, Reducing Valve.
112. Balancing Transformer (Back of S. T. and D. T. Switches).
113. Combined Strainer and Drain Cup.
114. D. T. Switch No. 1 Heater Circuit.
115. S. T. Switch Heater Circuit.
116. No. 1 Set Resistance Grids.
117. No. 1 Transformer.
118. Whistle.
119. Governor—Air Brake.
120. Distributing Valve.
121. No. 1 Blower Motor Fan Casing.
122. No. 1 Blower Motor.
123. No. 1 Air Compressor.
124. No. 1 Air Compressor Motor.
125. Permanent D. C. Field Shunting Grid No. 1.
126. No. 1 Fuse Box.
127. Canopy Switch for No. 1 Blower Motor.
128. Canopy Switch for No. 1 Compressor Motor.
129. No. 1 Motor-Control Cut-out.
130. No. 1 A. C., D. C. Change-Over Switch.
131. Water Tank.
132. Air Connection to Motors.
133. Motor Leads for No. 1 and No. 2 Motors.
134. Axle of Main Driving Wheels.
135. Upper Torque Rod.
136. Center Pin.
137. Lower Torque Rod (long).
138. Trap Doors Over Motors.
139. Heater Circuit Leads.
140. Air-Brake Piping.
141. Motor Armature.
142. Motor Field Frame.
143. No. 1 Oil Circuit Breaker.
144. Bus Line Socket Heater Circuit, No. 2 End.
145. Bus Line Socket Heater Circuit, No. 1 End.
146. Quill.
147. Tool Box.
148. Bumper Block.
149. Motor Suspension Cradle.
150. Spring Hanger.
151. Equalizer Spring.
152. Brake-Shoe.
153. Steam-Heating Line.
154. Equalizer Bar.
155. Series Transformer for A. C. Ammeter No. 3 and No. 4 Motors.
156. Preventive Coil, 100 Volts, 250 Amps. (back of No. 59).
157. Field Shunting Resistance (back of No. 58).
158. Series Transformer for A. C. Ammeter, No. 1 and No. 2 Motors.
159. Armature Spider.
160. Air Inlet to Transformer.
161. Air Inlet to Resistance Grids.
162. Third-Rail Shoe Leads.
163. Gage—Control Line Pressure.
164. Support for Motorman's Seat.
165. D. C. Wattmeter.
166. Blind Lights.
167. D. P., D. T. Switch for Battery.
168. D. P., D. T. Switch for Battery.
169. S. P., S. T. Switch for Motor-Generator Set.
170. Snap Switch for Motor Generator Set.
171. Insulators Supporting A. C. Trolley Cable.
172. Shunt for D. C. Ammeter Motors, No. 1 and No. 2.
173. Lower Torque Rod (short).
174. Motor Suspension Hanger.
175. Steam-Hose Coupling.
176. Brake Cylinder.
177. Foot Push-Button Switches.
178. Air Conduit.
179. Shunt for D. C. Ammeter Motors, No. 3 and No. 4.
180. Motor Leads for No. 3 and No. 4 Motors.
181. D. T. Switch, No. 2 Heater Circuit.
182. Independent Brake Valve No. 2.
183. Third-Rail Shoe Unlock Cylinder.

feeder through the circuit breaker to the bus bar. Upon the next bridge these conditions are reversed, so that each auxiliary feeder is divided into four mile sections.

Both rails of all tracks are bonded by means of No. 0000 compressed terminal flexible bonds placed around the fish plates.

ELECTRIC LOCOMOTIVES.

These locomotives were illustrated in this journal in May, 1906, page 184, and reference can be made to that article for details of mechanical construction as at present we will but briefly outline the general mechanical features and consider more fully the electrical apparatus, which was but briefly touched upon before.

The specifications under which the locomotives were built required that each should be able to handle a 200-ton train in a service requiring stops about every 2.2 miles, operating on a schedule of over 26 miles per hour. They were also to be able to haul the same weight train at from 65 to 70 miles per hour and a 250-ton train at 60 miles per hour. It was required that gearless motors should be used and that all the weight of the motors should be carried on springs. Since the locomotives are to operate on 600 volt direct current part of the time the specifications called for four motors, in order that they might be operated in the usual series parallel relation.

The two-truck type of locomotive was adopted, after careful consideration, as being the one best adapted to meet the conditions imposed. The underframe is necessarily of very heavy construction as it has to carry the full power of the locomotive from the center pins. It is located as low down as possible in order to get a direct pull from the draw bar. The cab is built up of a framework of Z-bars and covers the whole of the underframe.

The running gear consists of the two trucks, each mounted on four 62 in. driving wheels, and spaced with centers at 14 ft. 6 in. The armature of the motors is mounted on a spool which surrounds the driving axle but does not bear upon it. This spool is carried in bearings on the field frame and is connected to each of the driving wheels by seven large pins, projecting from the flanges on the ends, which fit into corresponding pockets formed in the wheel center. The pins do not fit tightly in the pockets, there being a clearance left for the insertion of helical springs, which are wound with their turns progressively eccentric. These springs are put in place under compression, both longitudinally and horizontally. By this method all of the power from the motor is transferred to the wheels through a yielding connection. The weight of the motors is carried on a steel frame entirely distinct from the truck and pivoted over the journal boxes. From this frame the weight is carried by springs on which the lugs of the field structure rest. The adjustment of these springs determines the portion of the weight that is carried by them, the remainder being supported by the armature quill or spool. The backward torque is transferred to the truck frame through rods, which permit a certain amount of vertical motion in the motor.

Armature Winding.—The active armature winding is closed upon itself and is not connected directly to different commutator sections, as is usually the case in direct current motors. It is, however, indirectly connected to the commutator through the preventative leads, which are a feature of the Westinghouse design of single phase motor. The active winding consists of several coils in each slot with one turn per coil. The function of the preventative coil or leads is to reduce to a low value the short circuit current caused when the brush passes from one commutator segment to the next. These leads serve the same function as preventative coils used in alternating current work when passing from one tap to another of the transformer. In fact the armature in one sense may be considered as a transformer with a lead brought out from each coil to the contact piece, the various contact pieces being assembled together to form a commutator.

There are several brushes per holder and both brushes and holders resemble closely those used for direct current work.

Field Winding.—The field winding is of the compensated type and is arranged in two circuits, viz., the main field coils, which

are placed around projecting poles on the field core and produce the active field flux, and the compensating field coils, which are placed in slots in projecting pole faces and serve to oppose the armature magnetomotive force and neutralize the reactance of the armature. The compensating coils remain at all times in series with the armature circuit, whether the machine is being

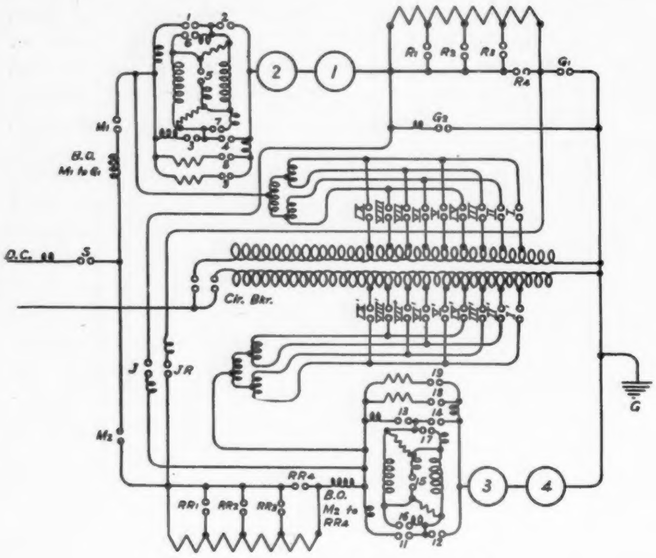


DIAGRAM OF LOCOMOTIVE CIRCUITS.

operated by a A C or D C current. Since during normal direct current operation the field coils receive twice as much current per armature ampere as when using alternating current, and since the active field coils in each motor are joined permanently in series and only two leads pass from the field frame for this purpose, two motors are operated as a unit and the separate field circuits of these motors are placed in series or parallel, as desired, according to the current being used.

Controller Circuits.—One of the illustrations shows a diagram of the locomotive connections. In direct current operation the four motors are arranged in two groups, and during acceleration these groups are connected in series and then in parallel. During alternating current operation each separate motor unit receives power at variable voltage from the auto transformer. The switches are interlocked so that the circuits used exclusively for one type of current cannot become active when the other type is used.

Referring to the illustration showing a diagrammatic view of the locomotive circuit and considering first the direct current operation, switches 2, 3 & 12, 13 or 1, 4 & 11, 14, according to the direction of operation, are closed so that the main field circuits of each motor are connected in series with their respective armatures. For starting, switches S, M 1 and J R are closed,

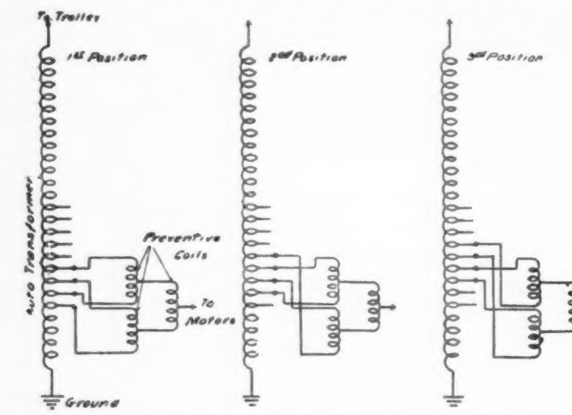


DIAGRAM SHOWING METHOD OF SHIFTING AUTO-TRANSFORMER CONNECTIONS.

thus connecting two complete motor units in series with each other and with eight sections of resistance. As the speed increases switches R 1, R 2, R 3, and R 4 of one motor unit and switches RR 1, RR 2, RR 3 and RR 4 of the other unit are closed in succession, thereby increasing the voltage in each unit until the two are in series across the line without resistance. Switches 8 and 18 are then closed, thus placing a resistance in shunt with the field winding and thereby weakening the fields and increasing the speed. This is followed by closing switches 9 and 19, which further weakens the field and increases the speed. The speed at this point is considerably more than ½ the normal running speed. The next movement of the controller handle opens switches 8, 9, 18, 19 and Jr and closes switches J, G 1 and M 2, thus putting each motor unit in series with four resistance sections and in parallel with each other. It will be noted that the transfer from series to parallel is accomplished without opening any motor circuit and without short circuiting either motor unit. Higher speeds are then obtained by cutting out the resistance from the circuits by closing switches R 1, RR 1, etc.

During alternating current acceleration no resistance whatever is used, the speed changes being obtained by variable voltages from different taps of the auto transformer. The first movement is the closing of switches 6, 7 & 1, 4, or 3, 2 and 16, 7 & 11, 14 or 12, 13, according to the direction desired. This places the main field circuits of the two motors of each unit in parallel, thus giving one-half the field magnetism per armature ampere, as is given during direct current operation.

There are six running points with alternating current, each corresponding to a certain voltage impressed upon the motor circuits. For changing from one voltage point to another on each auto transformer, use is made of three small preventative coils. These coils are essentially auto transformers having a ratio of 2 to 1. Referring to the diagram showing this connection it will be observed that the motor unit receives current from the middle connection of the coil whose terminals are joined to the middle points of two other coils, the outer terminals of which are connected to taps on the main transformer. In shifting from one running point to another the lower tap is opened and a connection is made with a tap four points higher up and so continued, each time the lower connection being opened and the

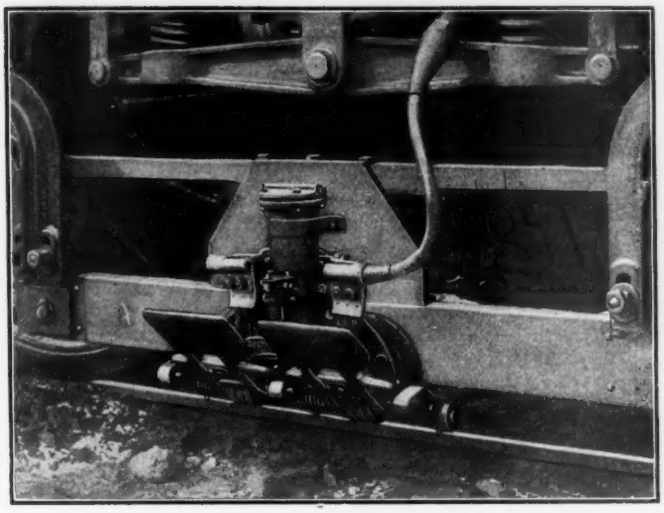
TOP VIEW OF MASTER CONTROLLER.

new one closed at the top. Thus at no time is the motor circuit opened or the transformer winding short circuited.

Switches.—Each switch used in the motor circuits is operated by compressed air of 80 lbs. pressure, which is controlled by valves operated by an electromagnet, which in turn is controlled by a current from a 20 volt storage battery, the battery being charged by an induction motor driven direct current generator. The switches are arranged in groups and are conveniently located in each side of the center aisle of the locomotive. The location and arrangement of all the apparatus is shown in the large illustration giving a cross section of the locomotive.

The master controller, a top view of which is shown, is of the drum type, the drum shaft being revolved by means of a handle resembling the throttle lever on a steam locomotive. The reverse lever is mechanically interlocked with the operating lever of the controller, so that all circuits must be dead before the reverse lever is thrown from one position to another. The row of knobs seen in the rear of the top of the controller are push

buttons for performing certain operations not connected with the main controller lever or reverse handle, such as putting the trolleys and third rail shoes up and down; resetting the main line circuit breakers; operating the track sanders and ringing the bell. These different operations are actually performed by



THIRD RAIL SHOE AND PNEUMATIC ATTACHMENTS.

compressed air, the push button merely completing the circuit from the storage battery to the proper air valve magnets. The bell and sanders can also be controlled by the foot pedals shown in one of the illustrations. In front of the motorman are air pressure gauges, a speed indicator, a direct current ammeter, an alternating current ammeter and an electrical pyrometer, the latter instrument indicating the temperature of the motors.

One of the illustrations shows the third rail shoe and its mechanism. This shoe must be capable of being held by spring pressure downward against an over-running rail, or upward against an under-running rail, and must also be capable of being lifted to clear any ordinary obstruction along the track where the third rail is not used. The shoes are hinged from a framework, which in turn is hinged from the face plate on the truck frame. The shoe frame may be thrown outward in a horizontal plane, or upward to an angle of 45 degs. from the horizontal by a toggle joint arrangement, which is operated electro-pneumatically. When the framework is in a horizontal position each shoe is held in place by a spring, so that it resists motion in either an upward or downward direction. The control of this mechanism is interlocked with the alternating current trolley, so that when the trolleys are up the shoes are also up and when the shoes are down the trolleys are also down; the trolleys can, however, be pulled down when the shoes are up.

In the cab are two air compressors driven by compensated motors of the same type as the main motors. The circuits to these are controlled automatically by the air pressure. There are also two motor driven centrifugal blowers, which furnish air for cooling the high potential transformers, rheostat, and the four large motors.

This air enters the motors at the armature shaft, passes around and between the armature windings, flows outward through the field coils and escapes through perforated caps in the frame of the motor. In addition to keeping the motor cool this scheme also prevents the entrance of any dust or dirt.

The locomotives measure 34 ft. 6 in. over bumpers and weigh approximately 90 tons. The motors have a normal rating each of 250 h.p. or 1,000 h.p. per locomotive. They were built by the Baldwin Locomotive Works and the Westinghouse Electric & Mfg. Company.

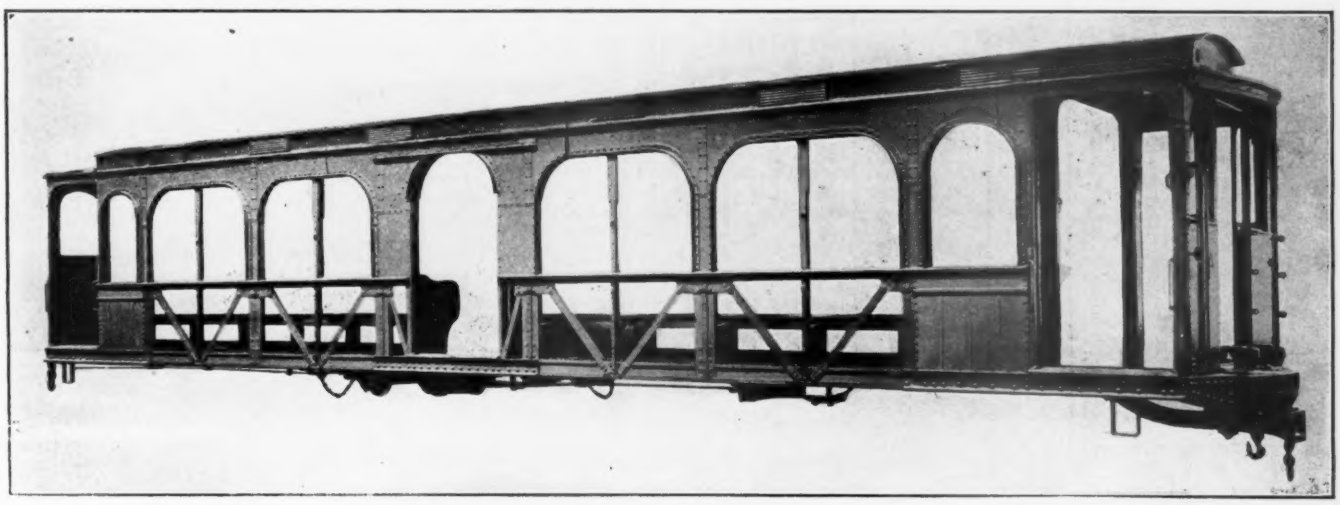
ALL-STEEL PASSENGER CARS.

HUDSON COMPANIES.

The Hudson Companies are receiving the first order of fifty all steel passenger cars, which are to be operated in their system of tunnels and subways. The design of these cars was preceded by a most careful study of the difficult conditions under which they are to be operated, which demand that the cars shall be absolutely fireproof, that they shall be arranged for the most convenient and rapid loading and unloading, and that they shall be as light in weight as possible in order to permit of the greatest acceleration and thus be capable of running on a high speed schedule with stops varying from 1/3 to 1/2 mile apart. A study of the accompanying drawings and description will show that all of these conditions have been fully complied with.

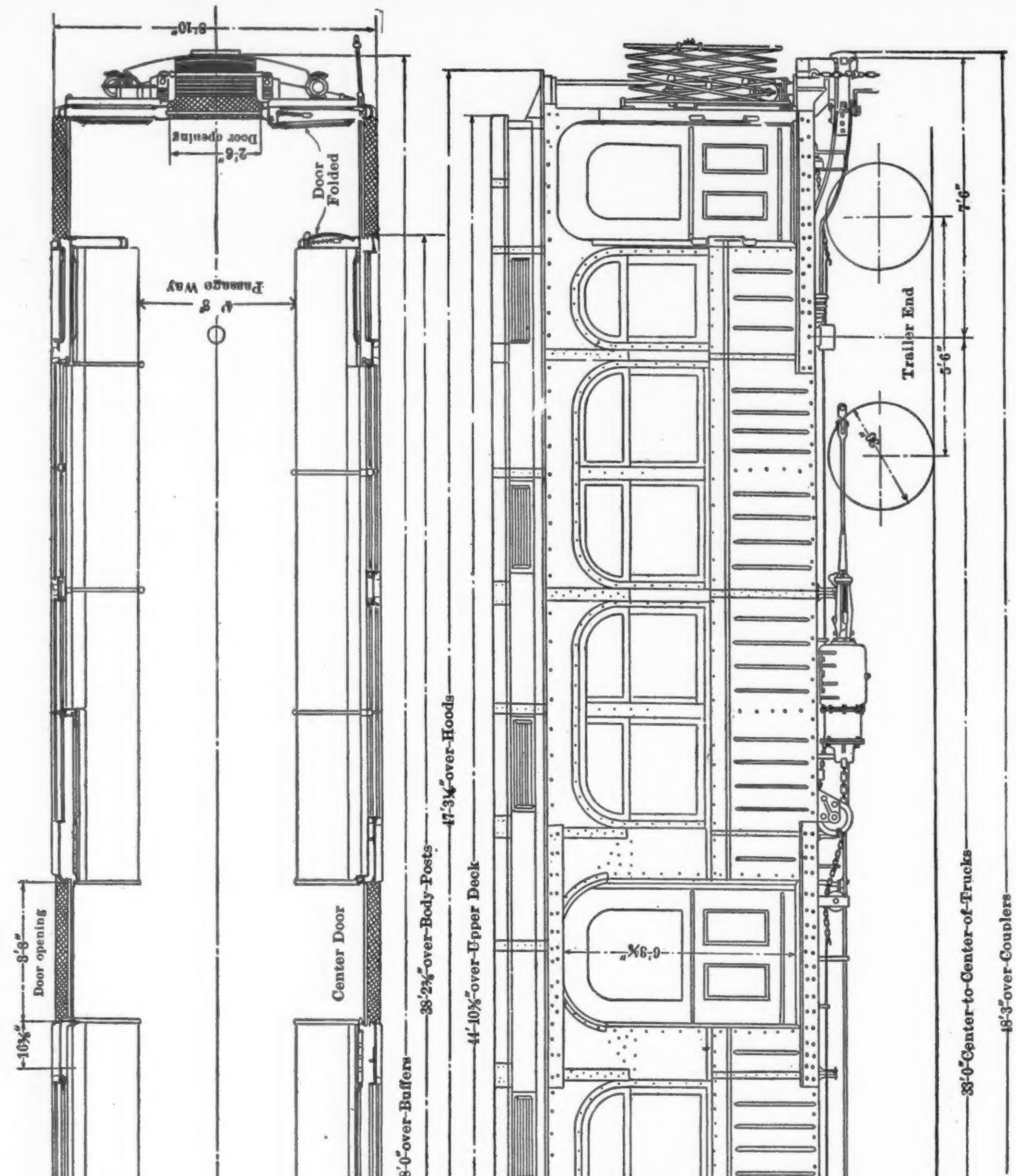
The tunnels and subways of this company are located under and on both sides of the Hudson River and consist first of a twin tunnel extending from Fulton and Church streets, New York City, below the Hudson River, to a point near the Pennsylvania Railroad terminal. From this point they continue as subways parallel with the river, with stations at the Erie and Delaware, Lackawanna & Western Railroad terminals. At a point midway between the latter two stations a pair of tunnels pass below the river, emerging in New York at Christopher and Greenwich streets, thence continuing as a subway along Christopher to 9th street, and thence under 6th avenue to 33rd street. There will also be a branch running west as a subway from near the Pennsylvania Station in Jersey City.

Work on all parts of this system is now in progress and it is expected that the section from Christopher and 9th streets, New York, to the D. L. & W. terminal in Hoboken, will be in operation by January 1, 1908. This will then be followed by other sections as rapidly as they can be completed. The second section to be put in operation will probably be the subway on 6th avenue.

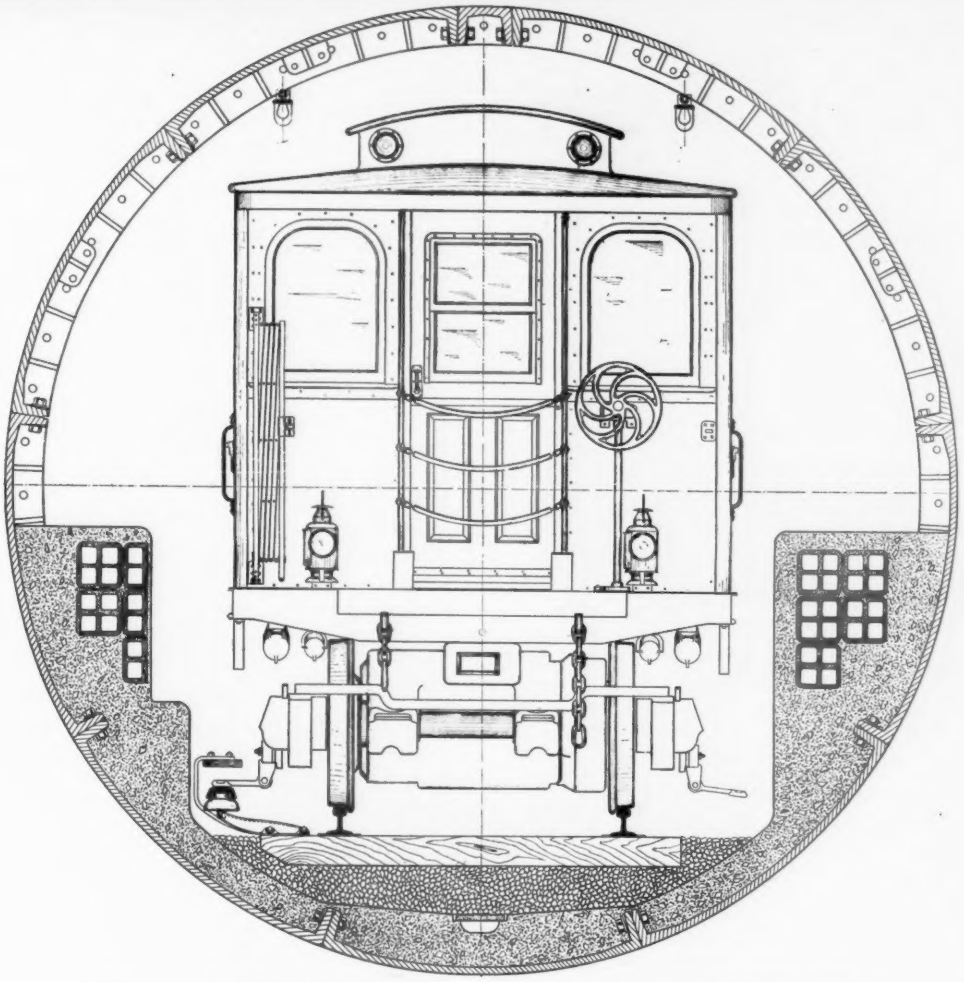


FRAME OF ALL-STEEL CAR BODIES—HUDSON COMPANIES.

The service in these tunnels will consist of trains of as many cars as are demanded, to a maximum of eight, running at as



PLAN AND ELEVATION OF ALL-STEEL CARS WITH CENTER DOORS—HUDSON COMPANIES.



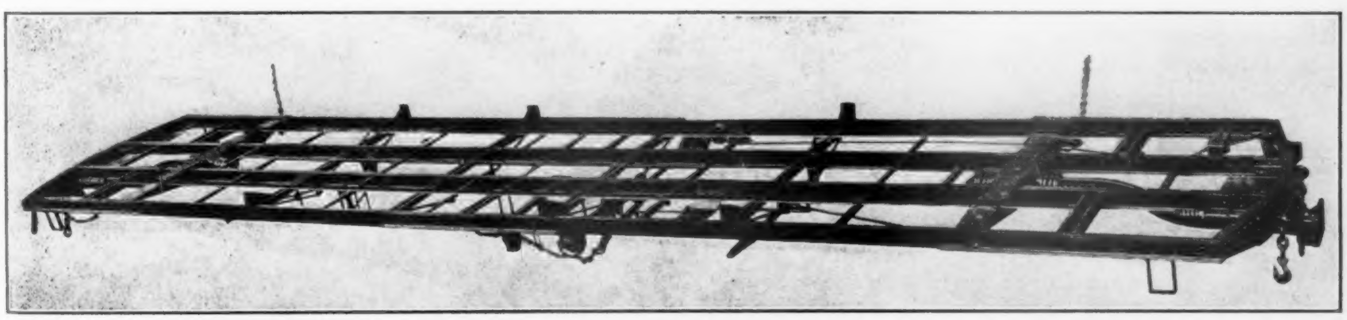
SECTION OF HUDSON RIVER TUNNELS SHOWING CLEARANCE OF ALL-STEEL CARS.

short headway as safety will permit. These trains will operate on the multiple unit system, taking current from a third rail. Direct current of 650 volts pressure will be used, being furnished by a large power house located in Jersey City, with such sub-stations as are needed. The whole system is of the double track type with loops at the ends.

The feature of the problem requiring the greatest amount of attention is the one of handling the enormous crowds of people during the rush hours, morning and evening, and of this, the matter of rapid loading and unloading the trains is the most difficult. It is on this point that the present rapid transit facilities in New York City are the weakest. It is believed, however, that the arrangement of platforms and design of cars, which are to be used by the Hudson Companies, will eliminate most of this trouble. At terminals, where the larger number of people are to be handled, it is planned to have a platform on either side of the trains, one for loading and the other for unloading, and the cars have been designed with a wide door in the center of the car in addition to the large doors at either end, and the end bulkhead of the car has been omitted to give free access to the end doors. Thus by opening the three doors on one side of the car and having an unobstructed platform, the car can be unloaded very rapidly and at the same time the doors in the opposite side being opened will allow it to fill in the same length of time without any confusion or crowding.

The illustrations show the appearance and construction of the cars, as well as a section of the tunnel below the river, in which they will be operated. From this it will be seen that the car is of the all steel type, being absolutely fireproof, even to the seat cushions and backs, which are covered with a metal fabric in place of the usual rattan.

The desire to use a center door made it impossible to design the car with the section below the window sills in the form of a plate girder, as has been done in most of the all steel short haul cars. It is also undesirable to support the car entirely from plate girders in the underframe, as this would add too greatly to the weight. Hence the car body and its load is supported entirely by a truss frame occupying the whole side of the car between the plate and sill. This truss is arranged in five panels, the center door occupying the middle panel. The bottom chord of the truss is a 6 in. channel forming the side sill and extending continuously from end to end of the car and the top chord

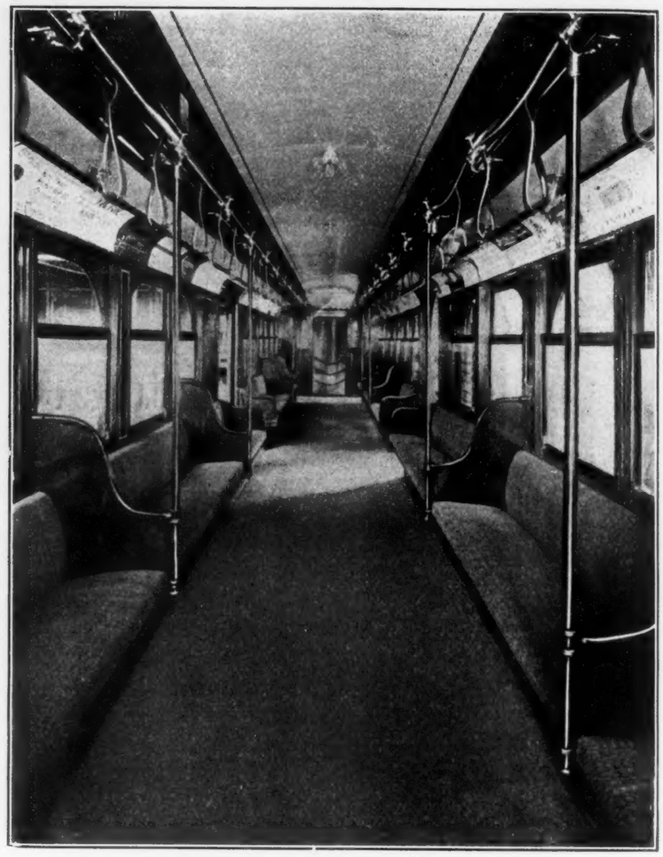


UNDERFRAME OF ALL-STEEL CARS—HUDSON COMPANIES.

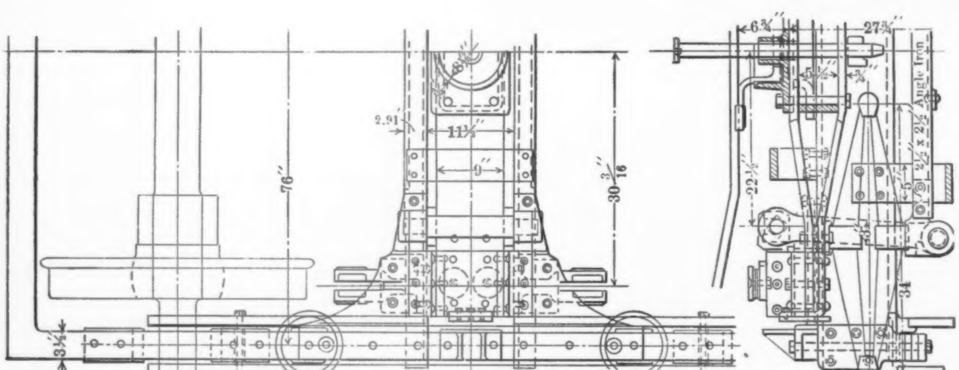
END VIEW OF ALL-STEEL CAR—HUDSON COMPANIES.

is a similar channel forming the side plate. The vertical parts of the truss are 8 in. channel posts, spaced uniformly and placed between the pairs of windows. Below the window sills these posts are braced by diagonal members to the bottom chord and above the windows they are reinforced by angle irons and steel plates, which arch over the pairs of windows and are riveted to the top chord. At the center door the top and bottom chords are reinforced by bulb angles, as is also the bottom chord below the end doors. This truss is designed to carry the entire weight of the car with the full passenger load and give a fiber stress not to exceed 12,000 lbs. per square inch in any part.

Underframe.—The underframe consists of 6 in. I-beams acting as center sills and running continuous from end to end of the car. The side sills are the 6 in. channels already mentioned. The bolsters are of the built up type and carry the spring draft gear in the center between the sills. The needle beams, of which there are four between the bolsters, are composed of angles set between and secured to the longitudinal sills. King posts are secured to the center sills at the needle beams and truss rods with turnbuckles transfer the load from the center sills to the



INTERIOR OF ALL-STEEL CAR—HUDSON COMPANIES.



MOTOR TRUCK—ALL-STEEL CARS FOR THE HUDSON COMPANIES.

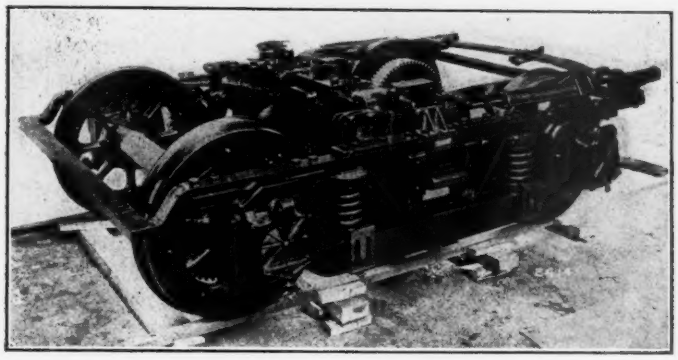
side truss. The end sills have been made unusually strong and consist of vertical plates reinforced by angles top and bottom, being curved to the contour desired for the end of the car. Connection is made to the center and side sills by heavy cast steel knee pieces. There are also two heavy steel castings riveted to the center sills, which extend upward about 8 in. above the buffer casting and act as a stop to prevent the telescoping of the car platforms in the event of a collision.

Side Sheathing.—The sheathing of the ends and sides of the car consists of steel plates 1/16 in. thick. These plates are riveted to the truss frame after the latter is in place and none of the rivets which hold the frame in place pass through the sheathing; thus it is possible to remove the sheathing plates for repairs without disturbing the truss.

The roof is supported by angle iron carlins bent to the proper contour and spaced about 14 in. apart. To these are riveted the 1/16 in. steel plates which form the roof. These plates are coated on both sides with lead and all seams and rivets are soldered to make them water tight.

Doors.—The six doors in the car are all of the sliding type, being supported by ball bearing hangers running on a track at the top. A piece of rubber hose is attached to the edge of the doors to prevent the possibility of pinching the fingers or catching the clothing of the passengers. The doors are of pressed steel and are operated by air cylinders, the piston having a stroke of about 15 in. and a rack and pinion being used to increase the movement. The operation of the air cylinders is controlled from air valves located at the ends of the car. A system of electric signals is provided, which indicate by means of a bell or light in the motorman's cab when all of the doors are closed and every door must be closed before the motorman can receive the signal to start the train.

Interior Finish.—The interior is finished with 1/32 in. steel plates as head lining and side panels. The window guides and post covers are also steel plates pressed to the proper form. The floor is made of monolith cement laid on galvanized Keystone iron. The top surface of the floor is coated with a layer of cement containing about 30 per cent. carborundum, which forms a hard wearing surface and gives a secure footing.



VIEW OF MOTOR TRUCK—HUDSON COMPANIES.

The seats are all longitudinal and consist of a steel framework on which rest cushions and backs covered with a metallic fabric. The seats were manufactured by the Hale & Kilburn Mfg. Co. Partitions, which consist of steel plates extending to a little above the shoulder of a seated passenger, are provided as shown in the plan of the car. The top edge of the partition is fitted with a 1 in. pipe bent to the proper curve. These partitions are high enough to form a support to the passenger and thus obviate the disagreeable effect of the sudden starting and stopping of the trains. A vertical hand rod is located at each of the seat partitions, extending from the seat to the ceiling fixture which supports the hand strap rod. These posts are intended as a convenient support for standing passengers.

Each car is lighted with thirty 10 candle-power incandescent lamps. There are two lamps in each vestibule, and switches are provided so that the current may be transferred from the two vestibule lamps in the end occupied by the motorman to the two lamps in the destination signals. In addition to the regular lighting equipment there is an emergency equipment of four lamps in each car, which are supplied from a 60 volt storage battery. In case the power should go off the line the emergency lamps would be continued to be lighted from the battery. The battery consists of 30 cells having a discharge rate of 1½ amperes for eight hours and is so connected that it normally floats on the line. The batteries were furnished by the Gould Storage Battery Company. The head and tail lights of the train, there being two of each, are the ordinary type of oil marker lamps. The heaters are of the panel type placed below the seats and were furnished by the Consolidated Car Heating Company.

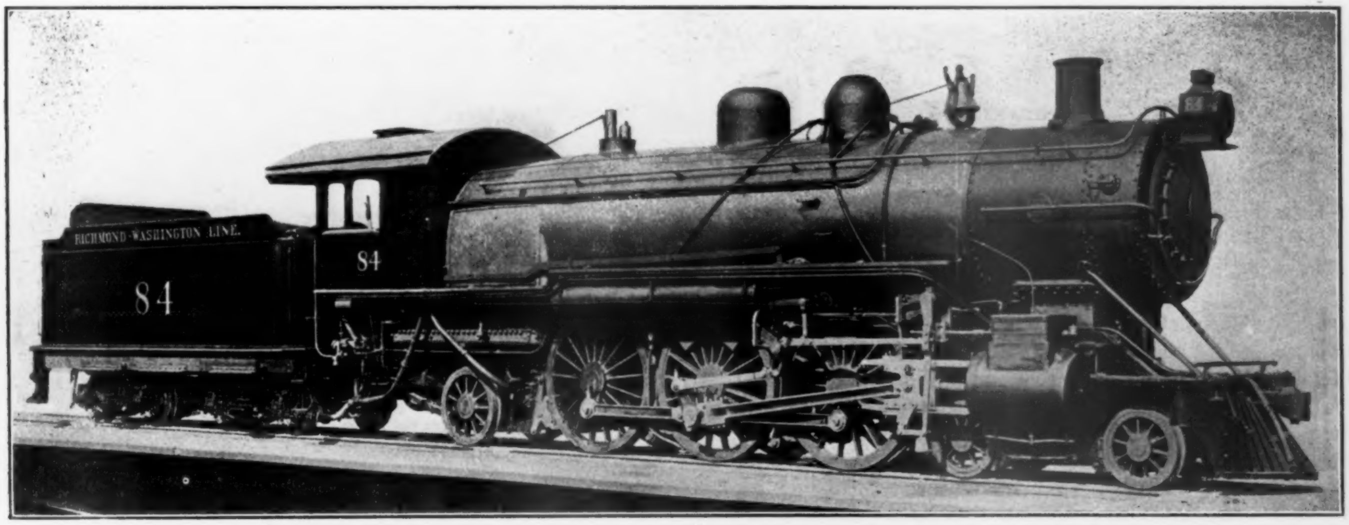
Control Equipment.—The latest type of Sprague-General Electric multiple unit control is used and a number of improvements have been made in the material used for insulation in order to render it fireproof. The control equipment of each car includes a current limit relay, which provides automatic acceleration of the train with predetermined current in the motors. This relay, however, does not prevent the operation of the master controller at less than the predetermined current if desired.

Each car is provided with two 160 h.p. motors known as the GE No. 76. This is a specially designed motor for this service and follows very closely the GE 66, the difference being in the armature speed and some improvements in the commutation.

Trucks.—The motor and trailer trucks were built by the Baldwin Locomotive Works and are shown in the accompanying illustration. They are of the M. C. B. passenger type, and the motor trucks have wheels with cast steel spoke centers and rolled steel tires held on by double retaining rings. One wheel on each axle has an extended hub upon which the driving gear is shrunk. The wheels of the trailing truck are of the solid steel forged type and were made by the Standard Steel Wheel Company. The motor truck has a wheel base of 6 ft. 6 in., 34¼ in. wheels and a 6 in. axle, while the trailer truck has a wheel base of 5 ft. 6 in., 30 in. wheels and a 4¾ in. axle.

These cars were designed and built under the direction of Mr. L. B. Stilwell, consulting electrical engineer, and Mr. Hugh Hazelton.

Of the 50 cars now being delivered 40 of the car bodies were built by the American Car & Foundry Company and 10 by the Pressed Steel Car Company.



HEAVY PACIFIC TYPE LOCOMOTIVE—RICHMOND, FREDERICKSBURG & POTOMAC RAILROAD.

PACIFIC TYPE LOCOMOTIVES.

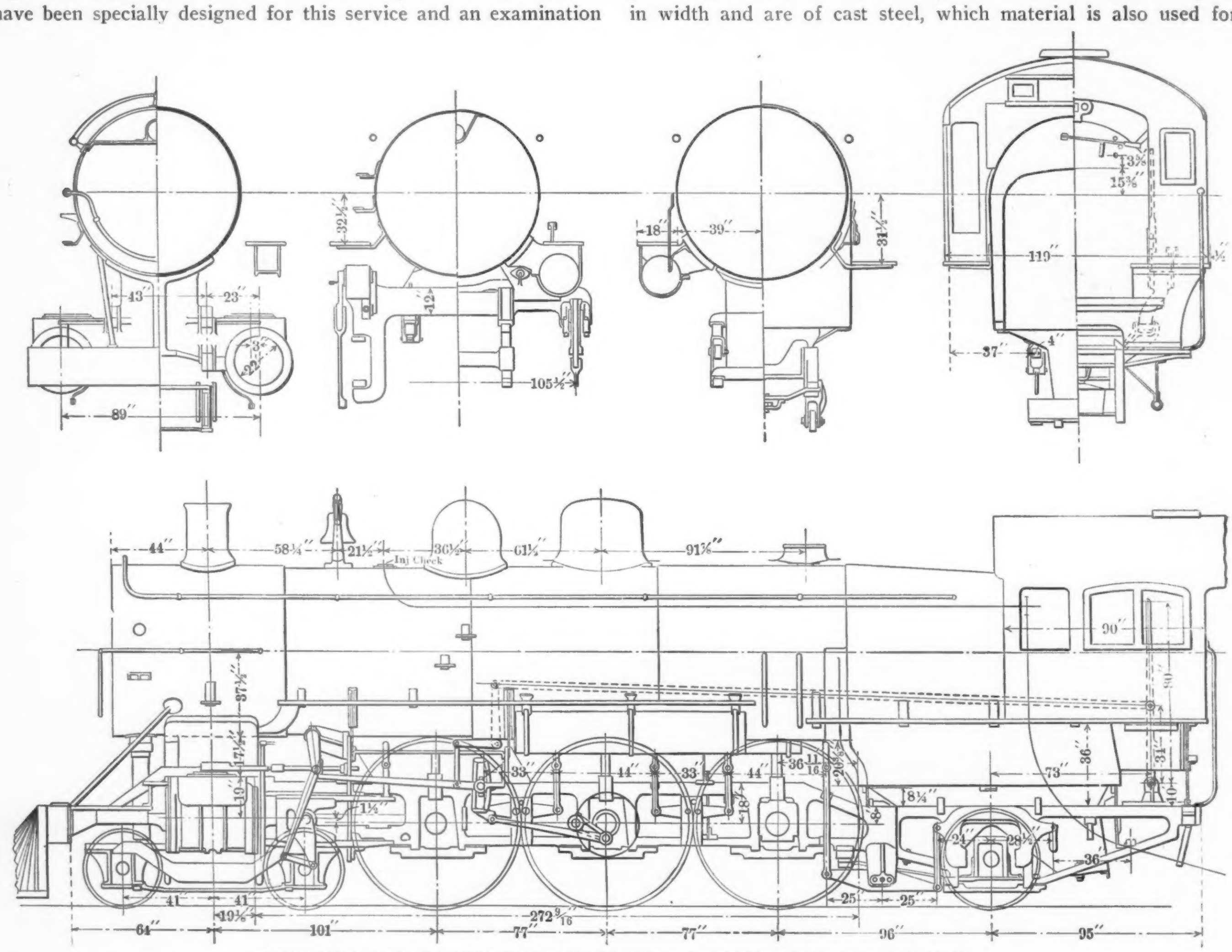
RICHMOND, FREDERICKSBURG & POTOMAC R. R.

The Baldwin Locomotive Works has recently delivered to the Richmond, Fredericksburg & Potomac Railroad six large Pacific type locomotives, which will be used for both freight and passenger service on that road. These engines have a large boiler capacity, a steam pressure of 200 lbs., 22 x 28 in. cylinders and 73 in. driving wheels. They weigh 230,800 lbs. and have a tractive effort of 31,100 lbs.

This railroad company operates about 125 miles of road, form-

ing a direct connection between Richmond, Va., and Washington, D. C., running through Fredericksburg, Va. The controlling grade northbound is .6 of one per cent. and southbound .8 of one per cent. The passenger traffic is very heavy, the trains often consisting of twelve or thirteen Pullman cars, but the freight service is practically all first-class, the average speed of freight trains on the line being about 35 miles per hour. These locomotives are intended for both classes of service and will handle 1,450 tons northbound and 1,100 tons southbound. In passenger service they are expected to haul the heaviest train on a schedule of 3 hrs. 30 min. between Richmond and Washington, the distance being 116 miles. There are five stops on the run and slow speed at several points. It is expected that after some track improvements are finished these locomotives will be put on a schedule of 2 hrs. 30 min. between Richmond and Washington, having but three intermediate stops. The locomotives have been specially designed for this service and an examination which would indicate that an excellent grade of fuel is to be used. The boiler is of the straight top type 74 in. in diameter at the front ring and contains 318 2¼ in. tubes 21 ft. long. The water spaces around the firebox are but 4 in. wide at the mud ring, indicating that the water supply is of good quality.

The general features of the design are evident from the photograph and general elevation. Balanced slide valves are used, being operated by Walschaert type of valve gear, the design of which, differing from other recent Pacific type locomotives, is arranged for hanging the links from a frame cross tie between the first and second pair of drivers instead of on a longitudinal support outside the front driver and extending between two frame cross ties. The motion is transferred from the plane of the link inward to the center line of the valve by a rocker arm supported from the guide yoke. This throws the center line of the valve 3 in. inside the center of the cylinders. The frames are 5 in. in width and are of cast steel, which material is also used for



ELEVATIONS AND SECTIONS OF HEAVY PACIFIC TYPE LOCOMOTIVE, R. F. & P. R. R.

of their dimensions and ratios would indicate that with the proper fuel they will easily be able to do the work.

The most noticeable feature of this design is found in the point of greatest importance for a high speed heavy passenger locomotive—*i. e.*, capacity of the boiler. An examination of the ratios will show that in this respect these locomotives are considerably above the average Pacific type. The B. D. factor (tractive effort × diameter of drivers ÷ total heating surface) is 560, a figure considerably below that ordinarily found in the Pacific type locomotive and one which, with two or three exceptions, is as low as any locomotives of this type on our record. Of those which are lower might be mentioned the large Pacific type for the Lake Shore & Michigan Southern Railroad, illustrated in our September issue, which gave 550, and the Michigan Central locomotive, illustrated in 1904, page 347, which gave 555. The other ratios concerned with the heating surface are also considerably above the average. The grate area is possibly somewhat smaller than usual for the amount of heating surface the driving boxes and wheel centers. The rear truck is of the Rushton type with inside journals. A liberal use has been made of the Tate flexible stay-bolt in these locomotives.

The general dimensions, weights and ratios are as follows:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. Coal
Tractive effort	31,100 lbs.
Weight in working order	230,800 lbs.
Weight on drivers	143,750 lbs.
Weight on leading truck	46,850 lbs.
Weight on trailing truck	40,200 lbs.
Weight of engine and tender in working order	350,000 lbs.
Wheel base, driving	12 ft. 10 in.
Wheel base, total	32 ft. 8 in.
Wheel base, engine and tender	61 ft. 11½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.62
Total weight ÷ tractive effort	7.65
Tractive effort × diam. drivers ÷ heating surface	560.00
Total heating surface ÷ grate area	82.90
Firebox heating surface ÷ total heating surface, per cent.	4.64
Weight on drivers ÷ total heating surface	34.90
Total weight ÷ total heating surface	56.10
Volume both cylinders, cu. ft.	12.30
Total heating surface ÷ vol. cylinders	334.00
Grate area ÷ vol. cylinders	4.03

CYLINDERS.	
Kind	Simple
Diameter and stroke	22 x 28 in.
Kind of valves	Bal. Slide
WHEELS.	
Driving, diameter over tires	73 in.
Driving, thickness of tires	3½ in.
Driving journals, diameter and length	9½ x 12 in.
Engine truck wheels, diameter	33 in.
Engine truck journals	6 x 10 in.
Trailing truck wheels, diameter	42 in.
Trailing truck, journals	8 x 12 in.
BOILER.	
Style	Straight
Working pressure	200 lbs.
Outside diameter of first ring	74 in.
Firebox, length and width	108 x 66 in.
Firebox plates, thickness	5/16, ⅜ and ½ in.
Firebox, water space	4 in.
Tubes, number and outside diameter	318—2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	3,917 sq. ft.
Heating surface, firebox	190 sq. ft.
Heating surface, total	4,107 sq. ft.
Grate area	495 sq. ft.
Center of boiler above rail	112½ in.
TENDER.	
Wheels, diameter	33 in.
Journals, diameter and length	5 x 9 in.
Water capacity	6,000 gals.
Coal capacity	12 tons

INSPECTOR'S REPORT FORM FOR NEW CARS.

The Seaboard Air Line has a convenient form for the use of its inspectors, in reporting the receipt of new cars from the builders. In addition to the general information at the top of the sheet, provision is made to show the wheel numbers, the dates they were cast and the pressure required to force each one on the axle. Each sheet is arranged to show this wheel data and the light weight for six cars. The reports are forwarded to the superintendent of motive power who, at a glance, can see just how many cars have been delivered on the order. The sheets are filed as part of a permanent record and can be referred to any time. The form was devised by Mr. B. O. Yearwood, one of the inspectors, to whom we are indebted for information.

SEABOARD AIR LINE RAILWAY
PORTSMOUTH, VA.
CAR INSPECTION No.............

Built by..

No. Cars..................*Capacity*..................*Kind*..................

Class............*Nos*............*to*............*inc*............*Journals*............

Wheels..*Axles*..

Springs..*Bearings*..

Couplers..*Air Brake*..

Brake Beams..*Draft Gear*..

For..

Reported to..*Date*..

Car Number	Wheel Number	Cast Date On Wheel	Ton-nage	Wheel Number	Cast Date on Wheel	Ton-nage	Maker's name
L. Wt.							

Number of Cars previously accepted..

Number of Cars accepted this date..

Number Cars accepted, Total..

Gen. Mechanical Inspector.
SECRETARY

ORGANIZATION.

A very common conception of organization is that it is an arbitrary arrangement by which orders are transmitted by various steps, through different groups of officials, from the man at the head of the organization to the many men who form the rank and file and do the actual work. Many graduates have shown that they believe that the way for a man in a high position to get a thing done is to order it done. Poor and inefficient administrators may do it that way. The successful administrators are men who act on the principle that their business is to administer unto those below them in the organization in three ways. First, by putting them into such places and under such conditions that they can do their best; second, by giving them orders necessary to show what is expected of them; and, third, by enlisting their wills as well as their bodies and minds in the work of the organization so that they will do their best. The first and third of these, the average graduate has never seriously thought of. He sees in the administrative officer the man who orders. The successful administrator finds his time so thoroughly filled with the first and third kinds of administration, with putting each man in the place and under the conditions most favorable to his effectiveness, and with enlisting in the service the will of the man, that orders fill but a small part of his horizon.

The men near the top in an organization normally do the most difficult work. Normally they are the men who work most intensely and for the longest hours. In the great organization with which I am connected, the civil service of the United States, this is so commonly recognized that it calls forth no comment to see the rank and file leave at four-thirty and come exactly at nine, while others who are in responsible control of the organization work early, late and strenuously.—*Mr. John Fillmore Hayford, from Commencement Day Address at the Clarkson Memorial School of Technology.*

Locomotives as Fire Engines.—The Pennsylvania Railroad has fitted out the switch engines working in its yards at Pittsburg and Altoona with fire pumps and hose and has trained the crews to act as a fire department. A system of whistle signals has been arranged to indicate in what part of the yard the fire breaks out, and all locomotives within a certain radius are uncoupled from their trains and rushed to that point. Yard masters and train directors arrange to give the necessary orders to provide a clear track to the scene of the fire and the signals are set indicating the routes for the locomotives to take. At a recent fire the first engine had a stream working within two minutes after the alarm sounded and within seven minutes nine engines were on the scene.

Wages and Prices of Food.—The annual investigation of the Bureau of Labor into wages and the retail prices of food shows that in the principal manufacturing and mechanical industries of the country wages were 4.5 per cent. higher in 1906 than in 1905. The hours of labor per week were 5.5 per cent. lower and the number of employees 7 per cent. greater. These figures apply only to wage workers and do not include salaried employees. The retail prices of food, weighed according to consumption in representative workingman's family, were 2.9 per cent. higher in 1906 than in 1905, hence the purchasing power of an hour's wage was greater in 1906 than the preceding year. Compared with the ten years from 1890 to 1900 the purchasing power of an hour's wage in 1906 was 7.3 per cent. greater.

Tests of Vanadium Steel.—The United Steel Co., Canton, Ohio, gives the following results of tests made on vanadium steel from a 30-ton heat poured at its plant. The tests were made of various portions of the steel subjected to different heat treatments. The figures in each case are the average of three tests:

Tensile strength, lbs	150,917	167,500	166,667	187,083
Elastic limit, lbs	143,333	161,667	160,833	181,667
Elongation, per cent	15	15	14.3	9.6
Reduction of area, per cent	54	51.6	50	30

Railroad Y. M. C. A.—It is stated that in the U. S. there are 231-railway associations in charge of the Y. M. C. A., but directly controlled by the railway management. Two hundred and twenty-one of these have a total membership of 87,860 and are growing at the rate of more than 10,000 a year. The current expenses of 214 associations were $930,573; the value of the buildings owned is more than four million dollars. The total attendance at 214 houses was 44,379. Fifteen new buildings were erected for this purpose last year at a total cost of $318,000. Twenty new buildings have already been assured for the coming year.

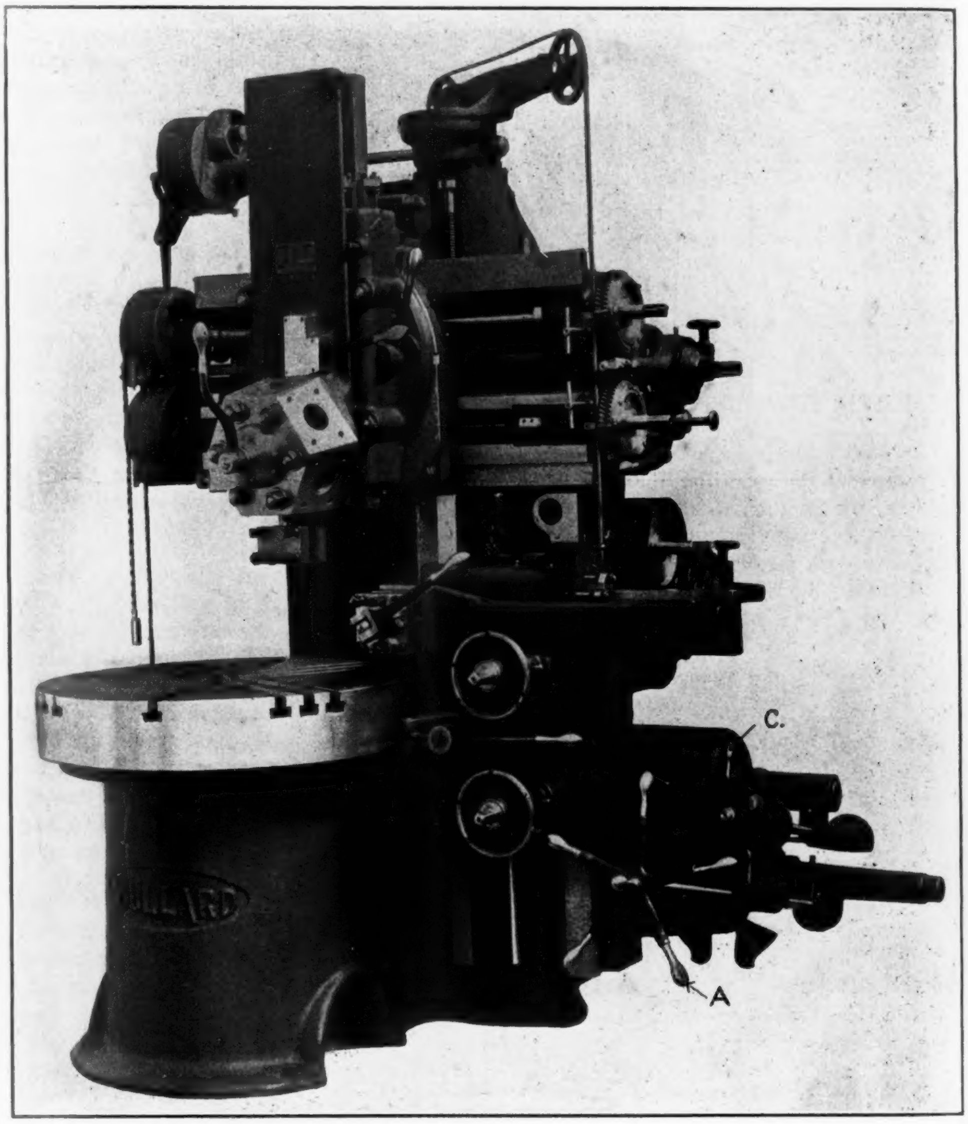
36-INCH BULLARD VERTICAL TURRET LATHE.

The Bullard Machine Tool Co., of Bridgeport, Conn., has for years been specializing in the manufacture of vertical boring and turning mills of both single and double head types, the latter construction, with its absolute independence of feeds for each head, having obviously greater productive capacity than single head machines of equal size. The tool equipment for this type of machine is simpler than for the ordinary horizontal turret lathe construction, due to the fact that the main turret head on the cross rail has a full universal movement, both vertical and horizontal, throughout the entire range of the machine, expensive overhanging cutters being thereby rendered unnecessary.

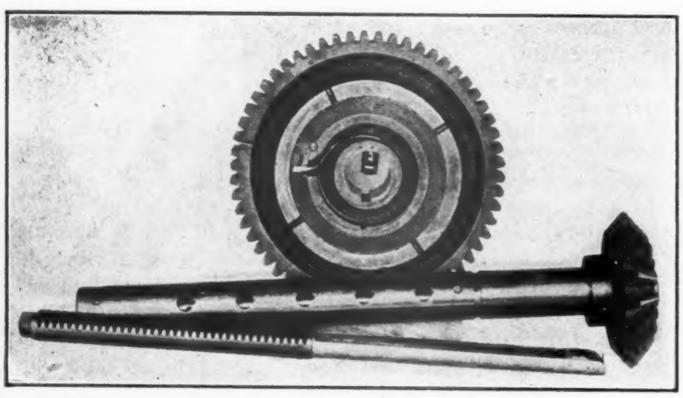
The proposition of equipping the smaller size machines with two heads, similar in design and construction to those in use on the larger tools, met with success only in a measurable degree, for there were many operations where only one head (where two were mounted in the conventional manner) could be brought into play unless the second head was swiveled to an excessive angle on the rail and extended from its supporting saddle to a point where the two tools could be used in a close proximity. The efficiency of the head thus used was materailly reduced and feeds and speeds were of necessity reduced to a point below the danger line—very little, if any, ultimate saving in time resulting from the use of two heads in this manner.

Mr. E. P. Bullard, Jr., in 1900 conceived the idea of practically swiveling that part of the rail carrying the second head to an angle of 90 degrees with the cross rail and in that way attaining the desired end—the saving in time made possible by the use of two tools working in close proximity on pieces of small diameter.

Six of these tools were built and placed in operation in various plants. For a period of four years they were under close observation with a view to possible improvement, the result being that an entirely new machine, embodying the side head feature in a much improved form, was placed upon the market in 1904. Feature after feature has been added—each with a view to greater productive capacity—until in the present machine the makers believe they have the most highly developed machine tool of its class on the market.



BULLARD VERTICAL TURRET LATHE—FRONT VIEW.

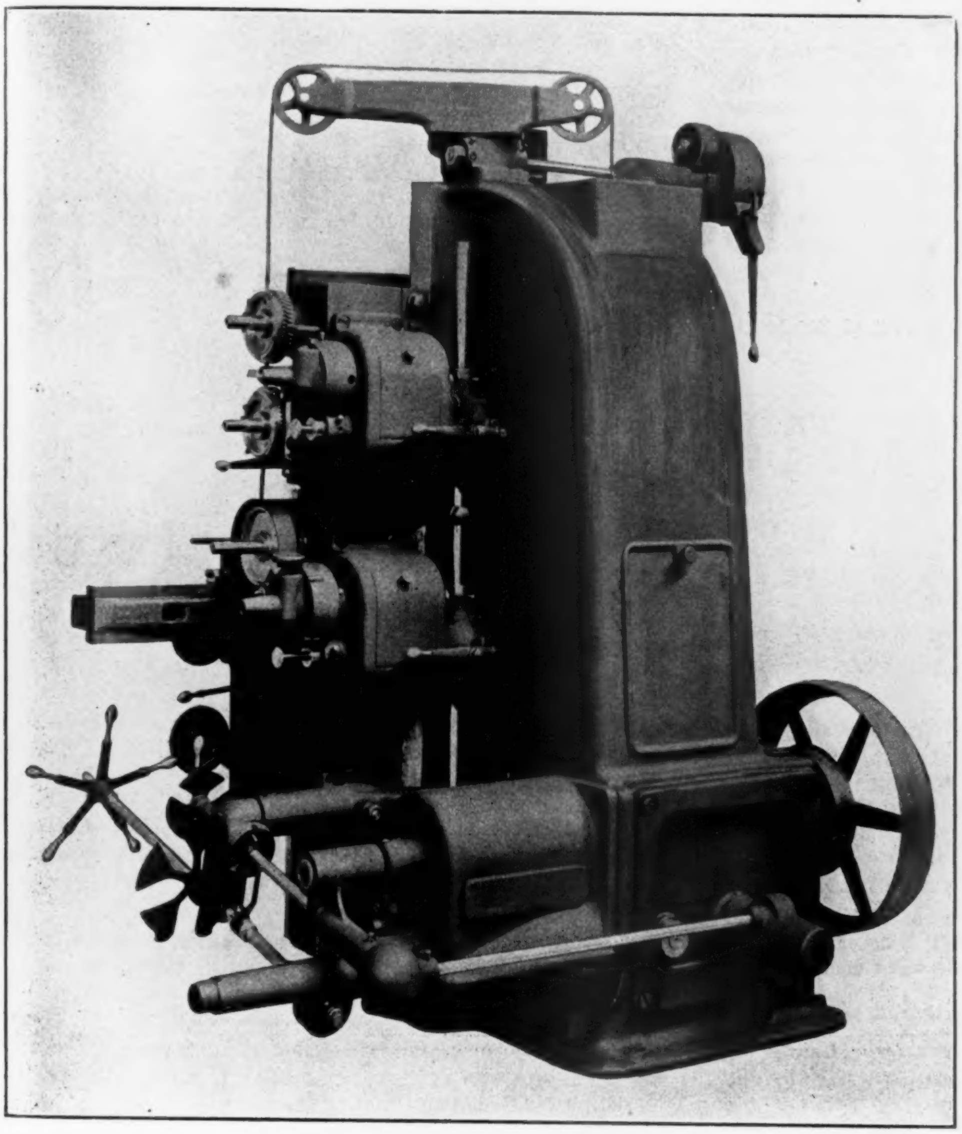

CONSTRUCTION OF FRICTION CLUTCHES.

As now constructed the machine consists of an exceptionally rigid bed of vertical box construction, internally braced against all strains incident to its duty, on which are mounted a cross and vertical rail. The extension of the bed base serves to support a table spindle of large proportions and permits of an exceptionally efficient system of lubrication whereby the spindle is at all times immersed in oil.

The machine is of the single belt speed and gear box construction, fifteen speeds being obtained by a set of gears and friction clutches, encased in the speed box shown at the side of the machine, in combination with three sets of reduction gears mounted as a unit inside of the bed and transmitting the power to the table by a spur pinion and internal gear. A notable feature of the drive is that there is no step up in the gear train, the first motion shaft running the fastest of all, with a continuous drop between it and the table.

Speed box changes, of which there are five, are obtained by revolving the pilot wheel A, each spoke indicating a speed which is engaged only when that spoke is in a vertical position. The quick acting brake is also actuated by lifting this lever. Headstock changes are controlled by the lever C which has three positions. The movements of these levers are all interlocking, to make conflict between them impossible. The engagement of the positive clutches in the headstock reduction gearing can only be effected when the brake is set, and the brake cannot be released until the desired change has been fully accomplished;

the speed box changes cannot be made unless the brake is disengaged, and the clutches are thus protected from harm. While protecting the driving mechanism from breakage, due to careless handling, this interlocking system in no way interferes with the rapid manipulation of the machine—any speed being obtainable without stepping from the working position.



REAR VIEW OF BULLARD VERTICAL TURRET LATHE.

The feed works for each head, while identical in design, are absolutely independent of each other. The eight changes are obtained, in two series of four, by opposed cones of gears constantly in mesh, "diving" keys being set by two handles on each feed box. Graduations showing the feed in engagement are conveniently located.

It will be seen from the photographs that there are no pull gears on the various feed rods. The change from vertical to cross rail, or vice versa, on the vertical head is effected by the engagement of the drop worm, centrally located between the rods. The same changes in direction of feed in the side head are obtained by clutches actuated by the horizontal lever shown between the rods on this part. Breakage of gearing by collision of the two heads is obviated by safety points incorporated in the feed train which, while simple, are very efficient.

Micrometer index dials graduated to thousandths are adjustably mounted on each feed rod and a scheme has been worked out in connection therewith which renders simple the reproduction of various diameters and sizes and at the same time does not present the limitations—mechanical and otherwise—of the automatic knock-off. It consists of indicators numbered to correspond to the turret faces which are set to the proper micrometer reading, as the correct dimensions of the first piece are reached. Calipering and measuring for depth are thus obviated on all but the first piece.

The handling of the main head by power, for rapid movement, is conveniently obtained through the key-handles shown at the right end of the cross rail, these handles operating plungers which pass entirely through the speed rod and screw and actuate clutches in the boxes shown at opposite end of rail. This mechanism is driven from the first motion shaft and its speed is constant and has no relation to the speed or movement of the table.

The maintenance of turret alignment has been solved effectively by placing adjustable taper gibs on both front and back bearings, the saddle being solid square locked throughout. The rails—both cross and vertical—are practically a unit and may be adjusted vertically, by power, to obtain the greatest efficiency of slides on work of varying length.

The construction of the friction clutches used throughout the machine is shown in one of the photographs. The spider is keyed to the shaft and the gear revolves freely thereon until the friction is engaged by forcing out the pin which actuates a spring lever. While this type of friction is practically self-adjusting the small wedge shown at fulcrum point has recently been added, rendering easy the adjustment, should any be required. Provision is made in the speed box construction whereby the adjusting points may be brought in line with a removable cap and no disassembling whatever is required.

Lubrication of all parts subject to wear has received careful attention; all gearing is in a constant bath of oil, gauges being conveniently placed which indicate the proper level to be maintained. The machine has a capacity of 36" in diameter and 24" in height and weighs 11,300 lbs. net.

Care of Locomotives in New York State.—One section of a new law which went into effect in New York State on September 1 states that, "it shall be the duty of every corporation operating a steam railroad within this State, and of its directors, managers or superintendents, to cause the boiler of every locomotive used on such railroad to be washed out as often as once every thirty days, and to equip each boiler with, and maintain thereon at all times, a water glass, showing the height of water in the boiler, having two valves or shut-off cocks, one at each end of such glass, which valves or shut-off cocks shall be so constructed that they can be easily opened and closed by hand; also to cause such valves or shut-off cocks and all gauge cocks or try-cocks attached to the boiler to be removed and cleaned whenever the boiler is washed out pursuant to the foregoing requirements of this section; also to keep all steam valves, cocks and joints, studs, bolts and seams in such repair that they will not at any time emit steam in front of the engineer, so as to obscure his vision. No locomotive shall hereafter be driven in this State unless the same is equipped and cared for in conformity with the provisions of this section; but nothing here contained shall be construed to excuse the observance of any other requirement imposed by this chapter upon railroad corporations, their directors, officers, managers and superintendents. Every corporation, person or persons operating a steam railroad and violating any

of the provisions of this section, shall be liable to a penalty of one hundred dollars for each offense, and the further penalty of ten dollars for each day that such violation shall continue. The board of railroad commissioners shall enforce the provisions of this act."

LOCOMOTIVE REGULATIONS IN CANADA.—The Board of Railway Commissioners in Canada has issued an order that all steam locomotives fitted with an extension smoke-box shall have a netting of a mesh not larger than 2½ per in. of No. 10 B. W. G. wire, to be placed in the smoke-box so as to extend completely over the aperture through which the smoke escapes. On engines with diamond stacks the netting must not be less than 3 per in. of No. 10 wire. The back of all ash pans shall be fitted with either a sheet iron damper, or screen netting dampers. This netting shall be inspected at least once a week and the report of the inspector be turned in to the commission. A penalty of $25 for each offense is made. No company is allowed to burn lignite coal on its locomotives under a penalty of $25 for each offense.

PERSONALS

Mr. R. E. Fulmer has resigned as master mechanic of the Illinois Central R. R. at Paducah, Ky.

Mr. J. A. Lewis has been appointed master mechanic of the Monterey division of the Mexican Central Railway.

Mr. M. M. Meyers has been appointed division master mechanic of the Missouri Pacific Ry. at De Soto, Mo.

Mr. C. O. Osborn has been appointed foreman of shops of the Chicago and Northwestern Ry. at Fond du Lac, Wis.

Mr. R. L. Doolittle has been appointed assistant master mechanic of the Central of Georgia R. R. at Macon, Ga.

Mr. I. T. James has been appointed master mechanic of the Missouri Pacific & Iron Mountain System at McGehee, Ark.

Mr. L. T. Gibbs has been appointed electrical engineer of the Baltimore & Ohio R. R., to succeed Mr. W. D. Young, resigned.

Mr. C. A. V. Axen, foreman of shops of the Chicago and Northwestern Ry. at Green Bay, has been transferred to Antigo, Wis.

Mr. S. H. Lewis, foreman of the Seaboard Air Line at Norfolk, Va., has been appointed master mechanic of the Virginian Railway.

Mr. W. F. Canavan has been appointed general foreman of locomotive shops of the Missouri, Kansas & Texas Ry. at Parsons, Kan.

Mr. George J. Duffy, master mechanic of the Canadian division of the Michigan Central R. R., with office at St. Thomas, Ont., has resigned.

Mr. B. F. Elliott has been appointed assistant master car builder of the Mexican Central Ry., with headquarters at Aguascalientes, Mexico.

Mr. R. D. Gibbons, master mechanic of the Mexican Central Railway at Monterey, has been transferred to the same position at Aguascalientes.

Mr. Thomas Yeager, roundhouse foreman at Bloomington, Ill., has been appointed master mechanic of the Illinois Southern Ry. shops at Sparta, Ill.

Mr. F. W. Peterson, master mechanic of the Chicago & Northwestern Ry. at Fond du Lac, Wis., has had his headquarters removed to Green Bay, Wis.

Mr. E. S. Fitzsimmons, general foreman boilermaker of the Erie R. R., has been appointed master mechanic at Galion, O.

Mr. R. A. Johnson has been appointed master mechanic of the Chihuahua division of the Mexican Central Railway.

Mr. F. W. Thomas, engineer of tests of the Atchison, Topeka and Santa Fe Ry., has been appointed supervisor of apprentices, with office at Topeka, Kan.

Mr. J. J. Tatum has been appointed superintendent of the freight car department of the Baltimore & Ohio R. R., with headquarters at Baltimore.

Mr. T. H. Russum has been appointed superintendent of the passenger car department of the Baltimore & Ohio R. R., with headquarters at Baltimore.

Mr. W. A. Bedell has been appointed master mechanic of the Missouri Pacific & Iron Mountain System at Van Buren, Ark., succeeding Mr. B. Donahue.

Mr. Charles James, master mechanic of the Erie Railroad at Galion, Ohio, has been appointed master mechanic at Port Jervis, N. Y., vice Mr. G. A. Moriarity.

Mr. A. H. Gairns, master mechanic of the Denver & Rio Grande R. R. at Denver, Colo., has been appointed master mechanic at Salt Lake City, Utah.

Mr. H. C. Ettinger has been appointed master mechanic of the Decatur & Springfield division of the Wabash Railroad, with headquarters at Springfield, Ill.

Mr. R. D. Smith, mechanical expert of the New York Central Lines, has been appointed assistant superintendent of motive power of the N. Y. C. & H. R. R. R.

Mr. E. E. Chrysler, general foreman of shops of the Chicago, Rock Island & Pacific Ry. at Chickasha, I. T., has been appointed division master mechanic at that point.

Mr. E. I. Dodds, mechanical engineer of the Pullman Company, has been appointed assistant mechanical superintendent of the Erie R. R., with headquarters at Meadville, Pa.

Mr. J. F. Bowden, formerly general foreman at Trinidad, D. C., has been appointed master mechanic of the Baltimore & Ohio R. R., with headquarters at Parkersburg, W. Va.

Mr. H. A. Beaumont has been appointed general foreman of the car department of the Baltimore & Ohio R. R., with jurisdiction over the Mt. Clare shops and Baltimore terminals.

Mr. B. H. Gray, master mechanic of the New Orleans Terminal, has been appointed superintendent of motive power of the Mobile, Jackson & Kansas City Ry., with office at Mobile, Ala.

Mr. M. S. Monroe, heretofore general foreman of the Chicago, Lake Shore & Eastern Ry., has been appointed master mechanic, with office at Joliet, Ill., and the former position has been abolished.

Mr. A. S. Grant, who recently resigned as master mechanic of the Missouri Pacific Ry. at De Soto, Mo., has been appointed master mechanic of the Texas Central R. R. at Walnut Springs, Texas.

Mr. E. D. Andrews has been appointed division master mechanic of the Chicago, Burlington & Quincy Ry. Lines West of the Missouri River at Sterling, Colo., to succeed Mr. F. Newton, resigned.

Mr. A. J. Poole, master mechanic of the Seaboard Air Line at Atlanta, Ga., has been appointed superintendent of motive power, with office at Portsmouth, Va. Mr. Poole succeeds Mr. R. P. C. Sanderson, resigned.

Mr. J. J. Hanline, master mechanic of the Birmingham division of the Seaboard Air Line, has been appointed master mechanic at Atlanta, Ga., succeeding Mr. A. J. Poole, promoted.

Mr. John Charlton, foreman of shops of the Chicago & Northwestern Ry. at Antigo, Wis., has been appointed division master mechanic at Chicago, to succeed Mr. L. M. Carlton, resigned.

Mr. W. F. Ackerman, superintendent of shops of the Chicago, Burlington & Quincy Ry. at Havelock, Neb., has been appointed assistant superintendent of motive power at Lincoln, Neb.

Mr. Thomas E. Layden, assistant engineer of tests of the Atchison, Topeka & Santa Fe Ry. at San Bernardino, Cal., has been appointed engineer of tests, with headquarters at Topeka.

Mr. O. Stewart has tendered his resignation as superintendent of motive power and equipment of the Bangor & Aroostook R. R. to take effect on October 1, at which time he will have completed 60 years in railway service.

Mr. W. L. Calvert, master mechanic of the Valley division of the Missouri Pacific and Iron Mountain system at McGehee, Ark., has been transferred to Cotter, Ark., as master mechanic of the Memphis and White River division.

Mr. F. E. Fox, master mechanic of the Colorado and Nebraska divisions of the Chicago, Rock Island & Pacific Ry., at Goodland, Kan., has been appointed master mechanic of the first division of the Denver & Rio Grande R. R., with headquarters at Burnham station, near Denver, Colo.

Mr. E. F. Needham has been appointed superintendent of the locomotive and car department of the Wabash Railroad, vice Mr. J. B. Barnes, retired. Mr. Needham entered the railroad service as an apprentice at the Fort Wayne shops of the Wabash Railroad in 1880 and has been with that company during his whole career. His headquarters will be at Springfield, Ill.

Prof. E. R. Dewsnup, who has been in charge of the railway courses at the University of Chicago for the past three years, has been appointed professor of railway administration at the University of Illinois at Champaign. This is a new position created for the purpose of enlarging and developing the new school of railway engineering. Professor Dewsnup will be associated with Dean W. F. M. Goss in developing this new school. Professor Dewsnup was born in England of American parentage, and received his education at the University of Manchester and the Royal Technical College of Manchester. After receiving his degree he spent considerable time in studying the operation, construction and management of railroads in the United Kingdom, France and Germany, and was for a time an officer on an English railway. He also visited the United States to study the railway system of this country, remaining here about a year. He then returned to England, but after a time was brought to the University of Chicago about three years ago to take charge of the railway courses.

BOOKS

Kahn System Standards. A hand-book of practical calculations and applications of reinforced concrete. Bound in paper; 4¾ x 7¾ in., 106 pages. Published by the Engineering Department, Trust Concrete Steel Company, Detroit, Mich. Price $1.50.

The object of this hand-book is to present to the user tables and information in such a form as to be immediately available for use in design. These tables are founded on scientific formula which has been approved by the best engineering practice. The data presented are obtained from an extensive experience in reinforced concrete covering the design and construction of over a thousand structures of all kinds. This book will be found of value to any one interested or concerned with reinforced concrete structures.

Brakes for Tramway Cars. By Henry M. Sayers, M. I. E. E. 5½ x 8½ in. Cloth. 76 pages. Published by D. Van Nostrand Co., 23 Murray street, New York. Price $1.50.

This book considers in detail the subject of brakes, especially as applied to street cars. The first chapter deals with the function of the brake and considers the coefficient of friction. The second, third and fourth chapters deal with wheel brakes of various forms, considering the efficiency and the influence of rail conditions, sanding, etc. Following this are chapters on braking practice, both mechanical and magnetic; on adjustment and maintenance of brakes and conclusions as to the choice and use of brakes. The final chapter gives constants and formulæ for calculations on brakes, accelerations and retardations. The book is illustrated.

The Work of the Running Department. By Henry Simpson. Bound in paper, 5½ x 8½ in. 106 pages. Published by the Swindon Engineering Society, Swindon, England. Price forty cents.

This book is a reprint of a lecture given by the author before the Swindon Engineering Society, which has been published in pamphlet form in order to meet the demand for extra copies. It has attracted much favorable comment in England and is considered of great value to the locomotive department. It supplies highly specialized information which, it is stated, has never before been published in connected form. It includes many blank forms for reports that are used on different English railways, both for inspection and repair of locomotives, and gives very complete information concerning the organization of different departments. The matter of proper design of roundhouses, water stations, influence of good and bad boiler waters, and the proper handling of power at the terminals are all discussed.

CATALOGS.

SNOW PLOWS.—The Wilder Snow Plow & Mfg. Co., Worcester, Mass., is issuing a small catalog illustrating and describing snow plows for steam and electric railways, one design being a radial plow for work on sharp curves. Both single and double-ended plows are illustrated.

ELECTRICAL APPARATUS.—The General Electric Company is issuing a number of new bulletins, among which might be mentioned Bulletin No. 4518 on the subject of electric hoists, which illustrates and gives tables of sizes of many different designs. Bulletin No. 4512 is on the subject of manhole fuse boxes, and No. 4520 deals with engine type continuous current generators.

NUT AND BOLT FASTENERS.—The American Nut and Bolt Fastener Company, Pittsburg, has issued catalog No. 5, which describes in detail the various types of Bartley nut and bolt fasteners which are used in railroad work. These different styles meet all the requirements for cars, locomotives and rail fastenings. Robert Spencer & Co., 20 Vesey street, New York, is the eastern agent, and Christopher Murphy & Co., 164 Dearborn street, Chicago, the western agent for the above company.

PRAIRIE TYPE LOCOMOTIVES.—The American Locomotive Company has just issued the tenth of its series of catalogue pamphlets, which illustrates and describes the Prairie type locomotives built for various roads. This pamphlet contains half-tone illustrations and the principal dimensions in tabulated form of fifteen different designs of locomotives of this type, ranging in weight from 136,000 to 245,000 pounds. The usual style of pamphlet adopted by this company is followed, beginning with the description of this class of locomotives and presenting the advantages which it offers for fast freight and passenger service.

METROPOLITAN INJECTORS.—The Hayden & Derby Mfg. Company, one of the subsidiary companies of Manning, Maxwell & Moore, 85 Liberty street, New York, is issuing an attractive illustrated catalog descriptive of its very complete line of injectors, ejectors, and jet apparatus. The catalog, in addition to describing in detail the action and construction of the different apparatus, also contains many excellent suggestions in connection with the selection of proper sizes and types for different conditions, as well as instructions to be followed in case of trouble, proper methods of connecting and operating, etc. Strainers, water heaters and other kindred apparatus are included in this catalog.

DRAFT GEAR.—The Waugh Draft Gear Company, 1525 Monadnock Block, Chicago, Ill., is issuing an illustrated catalog descriptive of its apparatus. This gear consists of groups of straight spring steel plates which under compression are curved over oval surfaces by movable blocks separating each pair of groups at their ends. It is claimed that in curving these plates from the straight position an easy graded cushion is obtained; the increasing curvature of the plates under compression is attended by a frictional adhesion between their individual surfaces, which adds to their cushion capacity and retards the return to the straight position, thus reducing the recoil. The apparatus is shown in a number of sizes, as applied to both wooden and steel underframe cars.

Chain Belts.—The Chain Belt Company, Park street and 11th avenue, Milwaukee, Wis., is issuing a general catalog, No. 35. This catalog, bound in cloth, contains 287 pages, and is a very complete work on the subject of chain belts. It is thoroughly illustrated and includes all information required for selecting chain belts for use in any kind of elevating, conveying and power transmitting machinery. Considerable valuable engineering matter in connection with this subject is included.

Superheated Steam on Locomotives.—A large and very completely illustrated catalog, printed in English, is being issued by the Schmidt Superheating Company, Ltd., of Wilhelmshohe, Cassel, Germany. This catalog gives illustrations of a number of locomotives fitted with the Schmidt superheater, and also contains line drawings and complete descriptive matter of the designs of improved superheaters now being supplied, together with details of the cylinders, pistons and valves, especially designed for superheater locomotives. The results of many tests and of actual service with locomotives using highly superheated steam are included. Many of these are comparative tests with saturated steam engines and illustrate very clearly the large economy resulting from superheat. The Schmidt type of superheater has been applied to a total of 2,315 locomotives.

Locomotive Cranes.—The Brown Hoisting Machinery Company, Cleveland, O., is issuing an illustrated catalog descriptive of locomotive grab bucket cranes. The illustrations show these cranes in operation, handling large amounts of ore, coal, sand, etc., at a rapid and economical rate. The grab buckets ordinarily used have a capacity of 24 cu. ft., or about 2½ tons of ore. Under their own power these cranes have the function of hoisting, rotating, traveling and of raising and lowering the boom. All of these functions, as well as the opening and closing of the grab bucket are under the control of one man. They are often used to push or pull cars and are equipped with sliding gears, so that the traveling mechanism can be thrown out of use and the crane hauled over the road at high speed. Cranes of this type have at many points proved to be very satisfactory for coaling locomotives and cleaning clinker pits.

Curtis Steam Turbine Generator.—The General Electric Company is issuing a very attractive pamphlet (No. 4531), which will be found of special interest to engineers on account of the information given therein regarding superheat, vacuum, economy, etc., and details of construction and operation of all parts of the Curtis turbine apparatus. The catalog is very thoroughly illustrated and the more important details are clearly described. Under the heading of "economy" a number of detailed tests are given of turbines from 1,000 k. w. to 9,000 k. w. capacity, which shows some remarkably high efficiencies. The efficiency curves are unusually flat, giving high figures at both overloads and light loads. This publication is typical of recent tendencies of large engineering firms to have their descriptive matter written by engineers and hence to contain matter of the highest engineering value.

Baldwin Locomotive Works.—This company is issuing two new pamphlets, one being "Record of Recent Construction" No. 63, containing illustrations and complete descriptive specifications of fourteen different locomotives of varied classes, which have recently been completed at its works. These include both passenger and freight locomotives of all types, principally for use on American Railways. A pamphlet of corresponding style is also being issued, which contains a description of the apparatus it has on exhibition at the Jamestown Exposition. This contains illustrations, specifications and a brief description of the different locomotives to the number of six, one of which is an electric; also two electric mine locomotives and several different designs of electric trucks. The exhibit of the Standard Steel Company, including rolled steel wheels, forgings and castings, is also described.

Electric Heating and Cooking Devices for Marine Use, is the title of a handsome publication just issued by the General Electric Company. A ship's lighting plant, usually of more than ample capacity for intermittent load, offers at once an available source of supply, which, utilized for cooking, heating, etc., would provide numerous real and profitable conveniences with small increase in cost. The electric heater, on account of its compactness, neatness, easy regulation and simplicity, is ideal for stateroom use. The General Electric Company manufactures several forms, including luminous radiators and non-luminous air heaters. One or two-quart water heaters, electric wash bowls and electric shaving mugs are familiar conveniences, and electric flat irons, in sizes from three to twenty-four pounds, are supplied for the laundry. Among special devices particularly serviceable on shipboard may be mentioned electric soldering irons, glue pots, curling iron heaters, surgeon instrument sterilizers, heating pads, cigar lighters, etc.

Twinvolute Turbine Pumps.—The Watson-Stillman Company, 25 Dey street, New York, is issuing sectional catalog No. 72, which is an assortment of sheets, selected from their large amount of printed matter, which relate especially to turbine pumps. This company has found that its great mass of catalog sheets, covering all classes of hydraulic machinery, has become too large to be given general distribution, so they have prepared a series of sub-divided catalogs, each of which deals with a special subject or class of machine. The catalog is thoroughly illustrated with line drawings and half tones and describes in detail both single and two-stage turbine pumps. These pumps are of a special and improved design, arranged for operation either horizontally or vertically, to be driven by gears, belt or direct connected to any prime mover. The results of a number of careful tests of different sizes of these pumps are included. A number of valuable tables in connection with the flow of water through pipes, equivalent water and mercury heads, power transmitted by belts, relation of horse power to water head, etc., complete the book.

NOTES

Gould Coupler Company.—At a special meeting of the Board of Directors of the above company, Mr. F. P. Huntley was elected vice-president and general manager, and Mr. George G. Milne was elected secretary.

Commonwealth Steel Company.—This company announces that it has moved into its new offices in the Pierce Building, opposite the Planters Hotel, St. Louis. It now occupies the entire southern wing of the sixteenth floor of that building.

Falls Hollow Staybolt Company.—This company announces that the fire which destroyed the greater portion of the building of its rolling mill, on September 13, did not damage the principal machinery to any great extent and that it is now in a position to promptly execute orders.

The T. H. Symington Company.—Mr. E. H. Symington, manager western sales of the above company, who was thrown from his horse and seriously injured a few months ago, has steadily improved and recently left for an extended trip around the world. Mr. Symington expects to be in his office at Chicago by the first of the year.

The Wm. Powell Company.—The increased demand for Powell's steam engineering specialties has made an enlargement of the plant of the above company at Cincinnati necessary. Plans are being prepared to erect buildings on the ground, 37 x 200 ft., recently acquired, and to increase the capacity of the power plant by 200 horse power.

American Blower Company.—This company announces that some recent installations which it has made, providing a circulation of air drawn over cooling coils, in the same manner as is usually used for heating, have been most successful during the recent hot weather. This was especially noticeable in foundries where it has often been necessary to curtail the production on account of the heat.

Wilmarth & Morman Company.—Among the recent shipments of New Yankee drill grinders to railway shops, were one machine each for the A., T. & S. F. Ry., the I. C. R. R. and the Jamesville & Western R. R., two to the Baltimore & Ohio Railroad and six to the Intercolonial Railway of Canada. This company also announces that it is delivering a large number of these machines to general manufacturing shops throughout the world.

Report of the Chicago Pneumatic Tool Co.—The semiannual report of the above company clearly indicates its very satisfactory financial condition. It states that the profits of the half year's business are $507,528, which after deducting two quarterly dividends, a liberal depreciation on buildings and tools, reserve for bond interest and sinking fund and over $10,000 for developing new tools, leaves a surplus of $190,819. This gives the company a total surplus of over one million dollars.

Court Decision on Noland Patent.—The outcome of the suit brought by the Westinghouse Electric & Mfg. Co. against the Prudential Insurance Company for infringement of the Noland patent in a generator owned by that company and manufactured by the Bullock Electric & Mfg. Co., is an opinion by Judge Lanning of the U. S. Circuit Court, holding the claims of the Westinghouse Company as correct and deciding that the construction used in the motor is an infringement of the Noland patent.

American Locomotive Company.—This company during the past few months has received a number of large orders for foreign shipments, especially to the far East. These aggregated in all 251 locomotives. One order of 183 locomotives, for the South Manchuria Railroad Company, is believed to be the largest order ever received by a locomotive company in this country for foreign shipment. This order is made up of six different types, all of which will be of American design throughout. Another order recently received was for three Mallet compound locomotives for the Central Railroad of Brazil, which will have a total weight, locomotive and tender, of 303,000 lbs.

Consulting Technical Advertising Company.—A company has recently been established in Chicago, which is devoted to a consulting practice in engineering and general technical advertising. It is prepared to render careful and expert service in advising the choice of mediums, preparation of advertising copy, changing of copy, and all other phases of dignified publicity. This is known as the Vredenburg Company, with offices at 1332 Monadnock Block. Its manager, Mr. Clarence Vredenburg, was editor and manager of the *Engineering World* from its inception until its recent sale, and has many friends in the technical field.

Annual Report of the American Locomotive Company.—The sixth annual report of the above company, issued on June 30, shows the gross earnings for the year to be $49,515,486.33, an increase of nearly seven million dollars. The net earnings were $6,771,105, an increase of $308,599. The net credit to profit and loss after paying 7 per cent. dividends on the preferred capital stock of $25,000,000 and 5 per cent. on the common stock of $25,000,000 was $1,358,206.93, an increase of $241,578. During the year the structural steel department established at Montreal was sold to the Structural Steel Co., Limited. The Montreal plant will hereafter devote its attention exclusively to the manufacture of locomotives, steam shovels and rotary snow plows.